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MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

SHADE TREES

BY

E. A. Start, G. E. Stone and H. T. Fernald.

The Massachusetts Forestry Association has co-operated with the station in the preparation and publication of this bulletin. For valuable suggestions and the sections on Shade Trees and the Law, The Tree Warden's Outfit and Duties, and Tree Guards, we are indebted to Mr. E. A. Start, the secretary of the association. The cost has been equally divided between the association and station. Besides the subjects mentioned above, the bulletin discusses the characteristics and value of the more important species of shade trees and their suitability for different environments; it gives brief directions for transplanting and pruning; describes the best methods of tree surgery, and includes chapters on the injurious effects of gas and electricity and the best methods of prevention. The more important insect enemies are described and the best known methods of treatment are given. The bulletin will prove of value to all who are interested in the planting and care of shade trees.

Requests for bulletins should be addressed to the
Agricultural Experiment Station,
Amherst, Mass.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

AMHERST, MASS.

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AGRICULTURAL EXPERIMENT STATION,
AMHERST, MASS.

CONTENTS.

SHADE TREES.

G. E. STONE, E. A. START and H. T. FERNALD.

The general interest in shade trees, particularly in the eastern states, well illustrated by the amount of money expended upon them and the many questions asked concerning their welfare, has created a demand for a brief practical manual covering the various questions relative to shade trees and their management. The Massachusetts Agricultural Experiment Station and the Massachusetts Forestry Association, having both had occasion to realize this need in their work, have united in the publication of this bulletin.

Shade trees add greatly to the desirability of a community as a place of residence, and their aesthetic value cannot be estimated in dollars and cents, but it is no exaggeration to say that the complete destruction of all the trees and shrubbery would reduce the valuation of some cities and towns fifty per cent.

Trees also possess a utilitarian value which is recognized by the courts, and for the careless destruction of street trees the abutter is entitled to compensation. A street tree adds value to real estate in the same way that a sidewalk or curbing does, but while the sidewalk and curbing may deteriorate a tree for many years increases in value.

Too much emphasis cannot be laid upon the care of shade trees. They, as well as crops, give the best results under cultivation, but unfortunately proper conditions do not always exist. Trees grow fairly well on lawns, however, especially when the lawn is occasionally fertilized, but mowings devoted to the production of hay are not at all suitable to the development of certain species, such as the elm. Many of the elms on our village greens, where no attention is given to their care, are unhealthy and sadly in need of better treatment. In many places they have been growing in sod for years where no fertilizer has been applied, and a hay crop removed annually, and in such cases one year's use of a plow and harrow, together with manuring and some kind of cropping, would work wonders. The leaves of elm trees under cultivation will change their color and double their size very quickly.

A tree in perfect health should make a vigorous growth and have large, dark green leaves, and the bark should be healthy in hue. If the conditions are otherwise the tree is not perfectly healthy and is more likely to fall a prey to certain diseases.

In applying remedies to trees it is well to be on the conservative side, since it is a very easy matter to cause them serious injury. The different spraying mixtures and banding substances recommended for trees are not always to be depended upon, and many trees are injured by their use, hence a word of caution is not out of place. Unfortunately at the present time it is necessary to be on the watch for bogus "tree doctors" and their stock of patent hypodermic injections guaranteed to rid trees and vegetation in general of insect and fungous pests, and other nostrums of a "sure-cure" nature. The tree warden should be, and often is, a man of intelligence and common sense and one to be called upon for advice pertaining to trees. There are also competent firms and professional men who are capable of giving advice in regard to the proper treatment of trees.

See "Woodland and Roadside," Vol. V, No. 3, June, 1906, and the Ann. Rept. of the Hatch Experiment Station for 1906.

THE LAW OF SHADE TREES.

E. A. START.

THE OFFICE OF TREE WARDEN.

For several years prior to 1899 there was a provision in the Massachusetts statutes that towns might elect tree wardens. By the act of that year it was provided that every town must elect a tree warden and the duties and powers of the office were defined. The tree warden law of 1899, with certain amendments in details, remains in force today and regulates the care of shade trees in every town in the commonwealth. It does not apply to cities.

The tree warden is an elective officer, with very complete powers in his own jurisdiction. He is responsible only to the body of citizens that elects him, although in the matters of making regulations and of locating trees to be planted he must act in conjunction with the selectmen. The warden's success in administering his office depends in a great measure upon the interest of the people of his town in their trees and the support which they give him. An intelligent, capable tree warden, well supported by his constituents, may be a power for good in maintaining and improving the trees of his town. The reverse of this proposition is equally true.

The tree warden holds a responsible position which carries with it a duty to his town. The trees that are put in his care are one of the chief resources for maintaining the beauty and health of the place. His duty is not merely the negative one of preventing cutting and disfigurement. He should plan systematically to maintain all existing trees at their maximum of attractiveness by careful, well-advised pruning, not careless cutting; by protecting with guards all promising young growth and all older trees that are liable to disfigurement by horses or otherwise; by preventing companies running wires above ground and pipes below ground from injuring the branch or root systems; and by planting or encouraging planting along roadsides. He should be an active apostle of the cause of the trees in his town, leading public sentiment and creating a better understanding of the value of good trees in the community.

The tree warden is elected at the annual town meeting,[1] and his compensation may be determined by the town, or in default thereof by the selectmen. He has the care and control of all public shade trees in the town, except those in such public parks, open places or roads as may be under the jurisdiction of park commissioners or state highway commissioners.[2] In some towns which have park commissioners, the tree warden is given the care of shade trees in the parks by the commissioners. The latter may, of course, entrust this work to the tree warden as well as to anyone else. but such an arrangement does not relieve the commissioners of ultimate responsibility for the park trees.

PUBLIC SHADE TREES AND THEIR PROTECTION.

Public shade trees are defined by the law as "all shade trees within the limits of a public way." [1] It may be assumed in the absence of a court decision on the point, that not only mature trees, but any young tree that is within the limits of a public way, and that now or in the future will add to the beauty and comfort of the highway, is protected by the law and within the warden's control.

The setting out and maintenance of public shade trees and the expenditure of money appropriated therefor is a part of the tree warden's duties ; and no trees may be planted by individuals without the approval of the tree warden, and after a location has been obtained from the selectmen, or road commissioners where authority has been vested in them.[1]

Regulations for the care and preservation of public shade trees may be made by the tree warden, with the approval of the selectmen, and when so made and approved shall be posted in two or more public places, and shall have the force and effect of town bylaws. Such regulations may impose fines of not more than twenty dollars in any one case.[1]

Public shade trees may not be cut or removed, in whole or in part, except by the tree warden, his deputy, or a person licensed by the tree warden to so cut or remove said tree ; and a tree may be removed only after a public hearing, at a suitable time and place, due notice thereof having been posted in two or more public places in

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1 R. L., ch. 11, s. 334.
2 R. L., ch. 53, s. 12, amended by Acts of 1908, ch. 296.
3 R. L., ch. 53, s. 12, amended by Acts of 1908, ch. 296.

the town, and upon the tree.[1] The hearing having been duly held, the tree warden may exercise his discretion in granting or refusing the removal permit. The hearing gives an opportunity for an expression of public sentiment. The warden is not subject to any action taken by citizens at the hearing, but it is presumed that he will pay due regard to the amount of interest shown, the representative character of the attendance, and the weight of testimony as to the benefit of removal or retention.

The laws expressly prohibit the mutilation, injury or disfigurement of trees, and in the case of public shade trees[2] it is the duty of the tree warden, under his general care of the trees, to see that these provisions are enforced. No one may wilfully and maliciously injure, deface or destroy an ornamental or shade tree in a public way or place, or negligently or wilfully suffer an animal driven by him or belonging to him to injure, deface or destroy such tree. No one may affix to a tree in a public way or place a playbill, picture, announcement, notice, advertisement or other thing, or cut, paint or mark such tree, except for the purpose of protecting it and under a written permit from the tree warden, or in a city from the officer having charge of said trees.[3] The penalty for violation of this statute is a fine of not less than five nor more than one hundred dollars, and a vigorous enforcement of its provisions, with the levying of fines in a few cases, will generally result in a very respectful attitude toward its provisions on the part of the public. It will, however, be found in most cases that a courteous warning, with information as to the exact purport of the law, will be sufficient to secure its enforcement.

The municipality has absolute control of trees within public ways as regards care, trimming, retention and removal, if public necessity requires, but when a tree is cut the wood is the property of the abutting owner.

The tree warden should at all times see that trees are so trimmed as not to obstruct in any way the proper use of the highway, or endanger travelers thereon. When locations have been granted to public service companies for wire, poles and equipment necessary to the proper conduct of their business, it becomes the duty of the tree

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[1] R. L. ch. 53, s. 13, amended by Acts of 1608, ch. 296.

[2] R. L. ch. 185, s. 7. and ch. 208, s. 100, 101, 102.

[3] R. L. ch. 208, s. 100, 101, 102, 104 (amended by Acts of 1905), ch. 279, s. 2.

warden to see that the trees are protected and given full opportunity for healthful and beautiful growth, but he should remember, at the same time, that the corporation should have a fair opportunity to carry on its business. This raises some delicate questions. The location of poles and running of wires on roads and streets lined with shade trees, without serious injury to the trees, often involves careful and intelligent study. It will generally be found possible to meet the conditions in a fairly satisfactory manner. If properly approached the companies will usually meet reasonable requirements without opposition. In case of trouble with linemen or foremen it is best to make a temperate statement of the case to the most accessible official of the company, when satisfactory orders to the men will usually be forthcoming. It should be borne in mind that the men at the heads of these companies are good citizens, law-abiding, and with an interest in maintaining the beauty of the state. Sometimes they are unwisely approached as public enemies.

The tree warden has no jurisdiction over trees on private land, but if such trees grow beyond the boundary of such private land and the branches interfere with any public use, that part which projects into the public way may be treated by the warden as if it were a public shade tree. Conversely, if a public shade tree projects over private property, so that it becomes a nuisance, as when the branches interfere with the windows of a house, the property owner may cut such limbs as overhang his line if the tree warden declines to do so.[1]

Tree wardens and owners of trees may obtain advice and assistance through the Massachusetts Agricultural Experiment Station at Amherst and the Massachusetts Forestry Association, No. 4 Joy St., Boston. The State Forester, at the State House in Boston, deals with all questions relating to trees in larger growths, as woodlots and forests. The bulletin of the Massachusetts Forestry Association, *Woodland and Roadside*, is published nine times a year, and is sent to every tree warden. It gives information as to methods of work, legislation in the state, legal cases involving tree law and other matters which the wardens should know.

[1] Holmes case (Lexington), decided by Judge Bond in the Superior Court, Oct. 1, 1907, an appeal from the District Court, Concord.

WOODLOTS AND HIGHWAY TREES.

In our country towns one of the most difficult questions arises from the cutting of woodlots having frontage on a public way. Often it is desirable that a fringe of trees or at least a row of selected shade trees within the highway be preserved, while the lot owner in too many cases wishes to cut them, and often does make a clean sweep to the roadway, in defiance of law. After the cutting is done, the only remedy is by a prosecution or an action at law. If the warden knows what is going on he can prohibit the cutting of any trees within the highway lines, and should enforce his prohibition. In either case his first step must be to determine the location of the highway lines, and this is the most difficult part of the case. It is most important that every town in Massachusetts should have its public ways surveyed and their lines determined. At present these are very vague, depending upon ancient layouts which perhaps were never accurately surveyed.

SHADE TREES ON STATE HIGHWAYS.

State highways form an exception to the jurisdiction of the tree warden, as heretofore stated. The exclusive care and control of all trees, shrubs and growths within the limits of state highways is given to the state highway commission, which has authority over all planting, trimming, cutting or removal on such highways.[1] The provisions in regard to defacement, injury or disfigurement are to be enforced by the tree warden, however, but should he fail to act in the case of a state highway within thirty days after the receipt of a complaint in writing from the Massachusetts highway commission, the commission may proceed through its own agents to enforce these provisions also.[2]

SHADE TREES IN CITIES.[3]

The law relating to city shade trees differs somewhat from that in towns. There is no tree officer specifically required by law. The mayor and aldermen, street commissioner and park commissioners

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[1] Acts of 1905, ch. 279, amended by Acts of 1908, ch. 297.
[2] R. L. ch. 208, s. 104, amended by Acts of 1905, ch. 279, s. 2.
[3] R. L. ch. 53, s. 6 (amended by Acts of 1908, ch. 296), and s. 7, 8, 9, 10, 11,

are the officials generally charged with responsibility for the trees. Springfield has a city forester, Newburyport and Fall River have tree wardens. The general law requires the authorization of the mayor and aldermen, or some city officer having the care of the public ways, for any planting of trees therein. Such trees are the property of the abutting owners, but may be removed by the mayor and aldermen if public necessity requires.

No one may cut or remove an ornamental shade tree standing in a public way in a city except after giving notice of his intention to the mayor and aldermen and receiving their consent.

The mayor and aldermen of a city are required during the last four months of each year to designate for preservation ornamental and shade trees, not otherwise protected, selecting at least one tree in every thirty-three feet where such trees are growing and are of a diameter of one inch or more. Such trees are to be marked by a nail having the letter M plainly impressed on its head, driven into the tree at a point between four and six feet from the ground on the side toward the centre of the highway. These nails are to be furnished by the secretary of the state board of agriculture. There is a fine of not less than five nor more than one hundred dollars for injuring, defacing or destroying trees so marked, or the nails affixed to them.

The use of M nails was formerly provided for in towns, but the present law placed all the public shade trees in towns under the protection of the tree warden, and the nails ceased to be needed.

The general penalties for injuring trees (chaps. 185 and 208, *Revised Laws*) apply alike to cities and towns.

TREES ON PRIVATE PROPERTY.

For injury to trees upon private property by persons other than the owner the law provides punishment by imprisonment not exceeding six months, and triple damages may be assessed for wilful injury of another's trees.[1]

[1] R. L., ch. 208, s. 100, and ch. 185, s. 7.

SELECTION, PLANTING AND CARE.

G. E. STONE.

SUITABLE TREES FOR STREETS AND ROADSIDES.

As a rule, those trees should be planted which are known to thrive well in the particular environment under consideration. Because a tree does not grow naturally in one locality is no evidence that it will not thrive in some other, and it is well known that the species of tree peculiar to wet places will grow in those inclined to be dry, but there is a limit to the adaptability of trees as regards their best growth, which should be taken into consideration. The nature of soils and other considerations, therefore, enter very largely into the problem of selection and planting of shade trees.

The following list* is taken from the report of Mr, W. F. Fox, Superintendent of State Forests, New York. It should be stated that there is considerable difference of opinion in regard to what are the best trees to plant; moreover, some of these trees might thrive in one location and in another be entire failures. Perfection is no more common to trees than to the human race, and since all trees have their defects the important question is to find those possessing the least. Some of the trees given in this list are not especially suited to Massachusetts, although in other states they would prove to be of value as street trees:

WIDE STREETS.	NARROW STREETS.
American or White Elm.	Norway Maple.
Hard or Sugar Maple.	White or Silver Maple.
Tulip Tree.	Red Maple.
Basswood (Linden).	Ailanthus.
Horse Chestnut.	Cucumber Tree.
Sweet Gum.	Ginkgo.
Sycamore.	Bay Willow.
White Ash.	Pin Oak.
Scarlet Oak.	Red Flowering Horse Chestnut.
Red Oak.	Black or Yellow Locust.
White Oak.	Hackberry.
Honey Locust.	Hardy Catalpa (speciosa).
American Chestnut.	Lombardy Poplar.

* Seventh Report of the Forest, Fish and Game Commission of the State of New York, 1903.

The **American elm** is one of the most widely planted trees in New England, and the best developed types are grand, majestic and more beautiful than any other tree known. It is difficult to make the elm thrive on dry, gravelly soil, and when growing in such situations it is inclined to be lanky. It is best suited to a fertile, more or less moist soil, and is well adapted to lawns and roadsides, but not at all to mowings. The high branching habits of this tree render it the best type we have for streets on which there are numerous wires. In recent years it has become infested with the elm leaf beetle, which has been the means of discouraging its planting. Olmsted Bros., landscape gardeners, say in one of their reports :

" We believe, however, that notwithstanding this objection (which, of course, can be more or less remedied by destroying the insects), there is no other sort of tree which so well gives the effect of a lofty, overarching canopy of foliage, which observation of village greens leads us to believe is the effect mostly to be desired."

The elm has a habit of shedding its leaves and its twigs, and is occasionally affected to some extent with a leaf fungus (Dothidella).

The **rock maple,** like the elm, has been extensively planted, and is comparatively free from fungous diseases. It is one of our handsomest trees, and will thrive on drier and poorer soil than the elm, but is susceptible to sun scorch.

The **tulip tree** is another excellent tree for roadsides, although not very much planted, and is probably better suited to lawns and country streets than to the hard usage it might receive on city streets. It is indigenous to different parts of Massachusetts, but it is not an easy tree to transplant and make live.

The **basswood, or American linden,** is a native of Massachusetts, but is seldom planted on streets, although it could be used to advantage. It is a beautiful tree, with bright green foliage and graceful and symmetrical when young.

The **European linden** is much planted and makes a fine avenue. The tree is not, as a rule, long-lived, however, and is often subject to frost cracks.

The **horse chestnut** was introduced from Europe, and is often planted on streets. It is not a long-lived tree, and is generally affected with a leaf-spot fungus (Phyllosticta), sometimes losing much of its foliage on this account, and often many of the twigs are winter killed and affected with Nectria. The red flowering horse chestnut is occasionally planted and is preferred by many.

The **sweet gum** is a native further south, Massachusetts appearing to be a little too far north for its best development, as it is often subject to winter killing and frost cracks.

Fine specimens of our **native sycamore** may often be seen on lawns and near roadsides, but it is seldom planted as a street tree with us. It is severely affected with a leaf-spot fungus (Glœosporium), which sometimes defoliates two-thirds of the tree. The younger twigs have been known to winter kill badly, but the tree will stand a great deal of hard usage and neglect.

The **white ash** grows fairly rapidly and often makes fine avenues. In poor, dry soil, however, it is likely to be attacked by borers and scale insects, and has suffered of late years from extremes of weather.

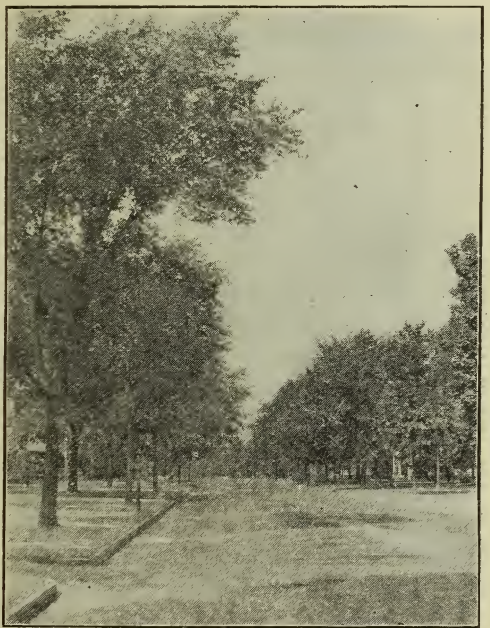

Fig. 1. Showing ideal tree-belt.

The **scarlet oak** is one of our most beautiful shade trees. It grows rather slowly under ordinary conditions, but is being planted more extensively than formerly. The beautiful scarlet foliage in the fall is much admired. As a native it is confined largely to dry soil, being associated generally with the yellow or black oak. It is, however, a difficult tree to transplant successfully. In many cases it has been effectively alternated with some tree of rapid growth, like the Carolina poplar, the poplars being removed when the oak has reached a fair size. On country streets and roadsides it should be more commonly planted.

The **red oak** is a common tree by roadsides, but is seldom planted on streets. This is a tree of fairly rapid growth, and may be used to excellent advantage as a roadside tree. Mr. John A. Pettigrew, Superintendent of Parks, Boston, speaks highly of the red oak, and states that no better trees can be planted than the red and scarlet oaks.

The **white oak** is seldom planted as a street tree, but makes magnificent individual specimens for lawns and roadsides. It is occasionally affected with a leaf spot fungus (Glœosporium).

The **honey locust** is not native with us, but may occasionally be seen growing along roadsides. City Forester W. F. Gale, of Springfield, states that he finds it easily broken by winds and susceptible to borers.

The **American chestnut** is seldom used for a street tree, although seedlings will make ornamental specimens of fairly rapid growth. They are regarded as dirty trees and are easily broken by winds, and when old require considerable pruning to dispose of the dead wood.

The **Norway maple** is a wide, spreading tree, with large leaves which give a dense shade. It is well suited for lawn planting and highly recommended for streets and roadsides.

The **white or silver maple** is not equal to the sugar maple, since it is more easily broken down by ice and winds. It grows very rapidly, and in Connecticut, where magnificent specimens may be occasionally seen, it attains a great size. It is planted to some extent on avenues. It is affected by a leaf spot fungus (Rhytisma), which, however, does little harm.

The **red maple** branches low and its foliage is inferior to that of the rock maple. During the past four years these trees have rapidly deteriorated in Massachusetts, owing to winter killing, and are dying in large numbers,

The **Ailanthus** may be termed a " scavenger tree," as it will grow anywhere and will stand harder conditions than any other tree. It is frequently found growing along railroad embankments, and often grows out of the side of a stone wall and on dumps, etc.; in fact, no conditions seem to be too severe for it. It is little used as a street tree, but excellent individual specimens may be seen here and there. If used as a street tree the fertile form should be selected, owing to the disagreeable odors arising from the sterile trees.

The **cucumber tree, or magnolia,** has been highly spoken of by many authorities as a roadside tree. Mr. Fox says that it fulfills all the requirements of a desirable shade tree.

The **Ginkgo, a Japanese species,** is occasionally seen on lawns, and forms a handsome avenue on the Agricultural grounds, Washington, D. C. It grows fairly well in Massachusetts, but better further south. We have seen large specimens of this tree in Providence, R. I., and it may be used under favorable conditions as a street tree, and is certainly worth trying.

The **pin oak** is native in Massachusetts only in the Connecticut valley, and when young is one of our most graceful trees. Its lower branches have a tendency to droop, consequently it is difficult to prune and maintain its characteristic beauty. It is well suited to lawns and narrow streets, where high pruning is not necessary.

The **black or yellow locust** is found growing spontaneously in many localities in this State. The old trees are often ugly in appearance and are very susceptible to attacks from borers.

The **hackberry,** which is closely related to our elm, is found occasionally in some of our river valleys and requires a good soil for development. City Forester W. F. Gale, of Springfield, advises planting this tree instead of the elm, as it is less susceptible to insects, and it is favorably spoken of by others.

The **hardy catalpa (speciosa)** is more at home in the west, although used here as an ornamental tree. With us it does not sustain its western reputation for growth, and there is at the present time some doubt as to its value as a tree for this locality, although some good authorities do not hesitate to recommend it.

The **Lombardy poplar** was formerly cultivated around dwellings, but owing to its habit of growth it gives little shade. It is used in parkways, and is occasionally planted for screens about dwellings. It is more or less susceptible to borers, but some good authorities recommend it for narrow streets.

Among other trees which might be mentioned is the **Carolina poplar,** which because of its rapid growth is extensively planted at the present time. Good avenues of these trees may be seen about Boston in the Metropolitan Park System, where they have been cut back to form a compact head. It is, however, subject to various troubles.

The **Italian poplar,** which grows even more rapidly than the Carolina, is occasionally used, but it is affected by a rust (Melampsora).

The **white poplar** is occasionally seen on streets, and makes exceptionally rapid growth.

The **yellow and swamp white oak** are handsome trees, and the latter might be used to advantage along country roadsides where the soil is moist.

Occasionally excellent effects are secured on roadsides by the use of **white pines, willows, Scotch larches and Norway spruces,** the latter sometimes being alternated with decidious trees.

Fig. 2. Showing entrance to cavity in tree caused by the removal of large limb and wound not properly cared for.

Many exotic species have recently been introduced, which may prove to be excellent shade trees. Among these may be mentioned the **Japanese elm,** which is a handsome tree of rapid growth.

The large and unrivalled collection of trees to be seen in the Arnold Arboretum furnishes good examples for consideration, and undoubtedly Prof. Sargent would recommend others worthy of trial. This list of trees was submitted to different persons familiar with the subject of shade trees and their care, in order to obtain their opinions in regard to it. Mr. E. W. Breed, Forester of the Massachusetts Highway Commission, who has had considerable experience in planting roadside trees, states that the first question in determining the varieties of trees to be used should be the soil conditions, and the next the width of the street, its kind, whether straight, curved, level or hilly, and the obstructions, such as electric wires, poles, etc. He mentions the following trees as being suitable for city and country streets :

For wide streets, the elm, rock maple and white maple, basswood, red oak and white ash ; and for narrow streets, the Norway maple, English elm, scarlet oak, ginkgo, red maple, bay willow. For country roadsides he recommends the tulip tree, chestnut, white willow, honey locust, white oak, pin oak, sweet gum, horse chestnut, cucumber tree, catalpa (speciosa), American larch and Ailanthus. He lays great emphasis on selecting the right tree for the right place.

Superintendent Pettigrew mentions favorably the following trees as being adapted to more or less severe conditions, and best suited to city planting: English elm, horse chestnut, linden, Ailanthus; while the rock, red, silver and Norway maples, the ginkgo, basswood, tulip, red and scarlet oaks, cucumber tree and hackberry are better suited to suburban planting. He recommends the Lombardy poplar as an excellent tree for narrow streets, but does not recommend the black or yellow locust, catalpa (speciosa) and sweet gum because they are not hardy in this region; the chestnut he does not recommend because it is subject to fungous disease.

Mr. Christopher Clark, the veteran city forester of Northampton, values highly the rock maple, tulip, all the oaks and the elms for wide streets; and for narrow streets he recommends the Norway, red and white maples, pin oak, red flowering horse chestnut, hardy catalpa, Lombardy poplar and bay willow.

City Forester W. F. Gale, of Springfield, recommends for wide streets the elm, hackberry, rock maple, tulip, white, scarlet and red oaks, linden and the sycamore; for narrow streets, the pin oak, Norway, red and silver maples, sweet gum, cucumber tree, catalpa (speciosa), ginkgo and red flowering horse chestnut.

Some mention should be made of the different kinds of shrubs growing along roadsides which greatly add to the attractiveness of country drives, and among these may be mentioned alders, viburnums, andromedas, clethra, cornels, New Jersey tea, sumach, spiraeas, shadbush, crataegus, witch hazel, etc. The duty of the tree warden is to see that these growths are maintained and not ruthlessly destroyed by highway surveyors who have charge of the roadbeds only.

The aesthetic value of these natural growths, constituting as they do the most charming landscape effects, is many times the economic value of the land upon which they grow.

RAPIDITY OF GROWTH OF TREES.

The variation in the growth of trees, due to the influence of many different factors, is very great, and even when trees of the same age are growing side by side great difference in the size and development are noticeable. A chestnut tree will, under certain conditions, attain a diameter of three feet in fifty-six years, while another may require one hundred and fifty years to reach a diameter of eighteen inches. The average diameter of twenty ash trees measured by us was sixteen inches in twenty years, and Italian poplars will occasionally grow twenty-six inches in the same period. On the other hand, many instances might be mentioned where trees have made very slow growth. To obtain the approximate growth of trees in any particular locality would require measurements of a very large number of specimens.

The following list, showing the average growth of trees, is taken from Supt. Fox's report, and represents approximately what a three-inch sapling will develop into in twenty years :

White maple,	21 in.	Yellow locust,	14 in.
American elm,	19 in.	Hard maple,	13 in.
Sycamore,	18 in.	Horse chestnut,	13 in.
Tulip tree,	18 in.	Honey locust,	13 in.
Basswood,	17 in.	Red oak,	13 in.
Catalpa (speciosa),	16 in.	Pin oak,	13 in.
Red maple,	16 in.	Scarlet oak,	13 in.
Ailanthus,	16 in.	White ash,	12 in.
Cucumber tree,	15 in.	White oak,	11 in.
Chestnut,	14 in.	Hackberry,	10 in.

TRANSPLANTING.

Too little attention is given to the details of transplanting. It is quite essential that attention should be paid to the soil and moisture conditions suitable for growth. Landscape gardeners recommend planting a few trees well rather than many poorly, and when one recalls the large amount of poor planting seen around dwellings and the weak-looking, half-fed, diseased specimens of trees and shrubs this advice will appear pertinent.

The funds of towns will not always allow the appropriation of a large sum of money for transplanting trees, and one must do the best he can with the conditions under which he has to labor. Special attention, therefore, should be given to the adaptability of certain species to conditions, since the cost of preparing suitable conditions is too often beyond the funds allowed for this purpose in most towns. Mr. John A. Pettigrew, Superintendent of the Boston parks, says that it is safe to say that if one has twenty dollars to spend on planting a street tree, nine-tenths of it should be spent on the preparation of the ground.

Olmsted Bros., landscape gardeners, in one of their reports to an association with limited funds, says in regard to the planting of elms :

" It would be better to prepare tree beds two to three feet deep and twenty to thirty feet square, filled with good loamy soil where the present ground is dry and sandy gravel, even if the expense of doing so would be so great that only one tree a year could be planted." Few trees, however, outside of those planted in the Arnold Arboretum and on a few private estates receive any such treatment, but it is hoped that much more attention will be given to good planting in the future. The majority of street trees which are planted are not supplied with loam or placed in holes over three feet wide and fifteen inches deep. A hole six feet wide by twenty inches deep in any case should be the smallest used, and it should be as much larger as can be afforded.

When digging up young trees the roots should be preserved as much as possible and the more earth that can be taken up with the roots the better. The roots should not be exposed to the sun and wind, and if possible they should be kept covered and moist, for which purpose damp straw, bagging or sphagnum moss may be used.

It is usually the practice to place the best side of the tree toward the north and the poorest toward the south, since the light conditions on the south side are better and naturally better growth results. It is also advisable to lean a tree toward the direction of the prevailing winds, and if these are strong enough to interfere with the growth of the tree it should be fastened to a strong stake.

When the ground is prepared for planting the injured roots should be pruned so that healing may take place, and before being covered they should be properly arranged in the soil. According to good authorities trees should never be planted more than two or three inches deeper than they originally grew. It is more convenient for two men to set out a tree than one, as one can hold the tree in its proper position while the other is filling the soil in around the roots.

The top soil, if of good quality, may be used, but it is better to discard the poorer subsoil and replace it with loam. Manure should be sparingly used and thoroughly incorporated with the loam, care being taken not to bring it in too close contact with the roots. Towns and cities which do much transplanting might make good use of composted street cleanings, and if land were available for a small nursery it could be used to good advantage by tree wardens and foresters.

When a tree is being set out the soil about the roots should be well tamped. Most people apply water to the roots at the time of transplanting, and if the season is an unusually dry one the watering may be repeated occasionally, but persistent watering is injurious and many young trees have been killed in this way. If trees are kept well tamped when set it is not essential that water should be applied at all, and it may even be injurious by washing the soil from the roots and leaving air spaces. One of the most essential features in transplanting is to secure as nearly as possible normal conditions of the soil about the roots.

Watering large trees near their trunks is not a wise practice, since the feeding roots are quite a distance from the tree, and one might suppose that an elementary knowledge of tree growth would discourage anyone from doing this.

After the tree is set, a mulching of hay, straw or horse manure containing much straw may be used to help to conserve the moisture in the soil and keep down the grass and weeds which rob the soil of its moisture and food.

Transplanted trees require a certain amount of pruning to accommodate the leaf and root systems to one another, and it is generally necessary to cut back the branches to meet these requirements. (See Pruning.)

There are differences of opinion in regard to the transplanting of trees, and undoubtedly more than one method may be followed. Opinions also differ in regard to the best time of year for transplanting, but it may be said that most people prefer the spring to the fall. We are of the opinion that it is not advisable to plant too small trees, preferring elms and maples 2½ to 4 or 6 inches in diameter, since they take hold of the soil better.

At the present day many very large trees and shrubs are being transplanted successfully, and special machines have been designed for use in this work. The Hicks tree mover, designed by Mr. Isaac Hicks of Westbury Station, Nassau county, N. Y., is extensively used, and Mr. Hicks has achieved remarkable results in handling very large specimens of trees and shrubs; but these tree movers are expensive, and for trees 6 to 10 inches in diameter a pair of high, heavy truck wheels, with some simple improvised arrangement, may be adapted. At the present time many individuals are willing to pay a good price for large trees, and for these tree movers are admirably adapted and should be more extensively employed.

Most street trees are planted too closely for their best development. For the larger trees 70 to 100 feet would not be too much to allow, although trees may be planted 30 to 40 feet apart and every other one cut out when necessary. The courage to do this is, unfortunately, often lacking. The limbs of very large maple trees would touch if planted 55 or 60 feet apart.

On modern streets a space, or tree-belt as it is called, should be set apart for trees, but if this is not available it is best to plant the trees inside the sidewalk, as there they are much less likely to be injured by horses.

PRUNING.*

Besides the necessary pruning at the time of transplanting, the removal of dangerous dead wood and branches every two or three years is essential, and in the case of street trees the lower branches should be cut. When limbs are so close as to interfere it is best to remove them, and this should be done when the trees are young, in order that a better crown may be ultimately obtained. Mr. W. F. Gale, City Forester of Springfield, makes a practice of thinning and shaping his trees when young, thus obviating the necessity for too much thinning when the tree reaches maturity. The amount of dead wood annually found in trees is frequently quite large, and it costs about as much to dispose of it as it does to prune it.

In towns a distance of 10 or 12 feet or more may be left between the roadway and the lowest limbs, but in cities the nature and amount of traffic necessitates higher pruning. When trees are growing

* The reader may consult "The Pruning Book," by L. H. Bailey, Macmillan & Co.; also "A Treatise on Pruning Forest and Ornamental Trees," by A. Des Carr, translated by Prof. C. S. Sargent, and published by Mass. Society for the Promotion of Agriculture.

thickly on streets it is often necessary to prune them high to let in sufficient sunlight, and when different types of trees are planted together, such as maples and elms, high pruning is often resorted to in order that the high canopy or Gothic arch effect formed by the elm trees may not be destroyed, and if a more or less conventional type is desired in individual specimens the removal of certain limbs often changes the contour of the trees, much to the advantage of the surroundings. We do not believe it is desirable to prune the feathery growths often found on the trunks of elms, as they are apparently protective in nature ; moreover, in our estimation they add to the

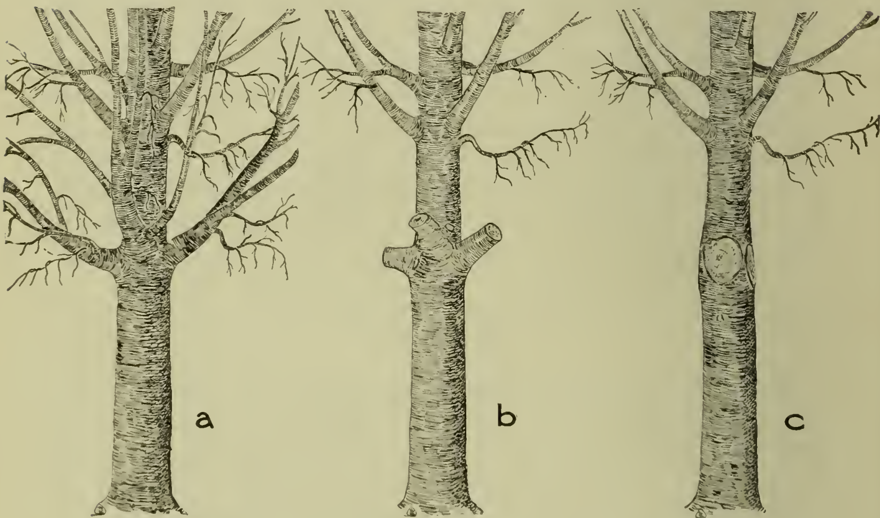

Fig. 3. Showing the proper method of pruning large limbs. a, tree before planting, b, showing relative distance of first cut from the tree trunk. c, the same with limbs cut close and the scars finished with a mallet and chisel.

beauty of the tree, taking away much of its conventional appearance.

As a rule the limbs on vigorous maple trees will droop about one foot or more a year owing to their increased weight, and it is only a short time before they become too low. Limbs over a sidewalk may be left lower than over roadways. During rain and sleet storms limbs are heavily weighted and often give trouble when too near the ground.

On country roadsides pruning should be high enough so that the limbs will not interfere with the hay and wood traffic which is common on suburban roads. All limbs should be cut as close as possible to the tree, and cuts over 1½ to 2 inches in diameter should be painted with thick lead, tar, shellac or some such substance to prevent decay. Strictly horizontal cuts should never be left, since they retain water and rot is likely to result, and the cleaner the cut the better it will heal. There is, moreover, less chance for subsequent rotting.

Many of the cavities in trees are caused by leaving long stubs on the trunk of the tree, which become disintegrated and fall off, and the decay follows back into the heart of the tree. (See Fig. 2.) It is therefore essential that close pruning and antiseptic treatment of the wounds should be practiced in order to prevent this decay. The plastic materials in a tree will not follow up a long stump and form a callus unless there are some branches left upon it which bear leaves, and even then healing will take place only close to the living branch on the stump.

Two cuts should be made in pruning practically all limbs to prevent peeling, and on limbs of any size it is necessary to make the incision on the under side for the same reason. (See Figs. 3 and 4.) After removing the limbs with a saw, a mallet and chisel may be used to smooth up the cut surface. This induces a better callus growth. It is well to prune carefully at the time of transplanting, when all street trees should be trimmed up 8 or 10 feet or more. It is also often necessary to cut back some of the branches in order to balance the root system, and when this is done some of the less desirable branches may be sacrificed, and those remaining may be cut back to some extent.

The practice of topping trees is injurious and should never be resorted to except in special cases. All of the reserve material in the tree is stored in the roots, stem and branches, and in a transplanted tree this is sufficient to develop the foliage. It is necessary that a tree should have a certain amount of foliage for growth and development, since the rapidity of growth is dependent upon leaf development.

The type of trees termed "bean poles," or trees with the tops cut away to such an extent that there are no limbs left, is not suited, therefore, to transplanting. Such trees as the willow will survive any amount of mutilation, but elms, maples and others must be handled more carefully to obtain the best results. Pruning the branches of trees directs the energies of growth to the trunk, whereas topping or the destruction of the leader has the reverse effect. Continual pruning of the lower branches induces the tree to grow taller than it otherwise would, and in some locations is advantageous to the tree. Topping is destructive to the formation of typical crowns in such trees as the elm, hornbeam, etc., whereas in other trees, like the Carolina poplar, topping or pollarding has a tendency to thicken

Fig. 4. Showing too common method of pruning limbs, resulting in the disfiguration of the tree. a, tree before pruning. b, limb cut too close, resulting in the peeling of the bark. c, unsightly wound caused by this method of pruning.

them up and make them more desirable shade trees. The configuration of the crowns of maple trees is modified to some extent by topping them when they are young, and this modification is manifested by the branches assuming more of a vertical direction.

The cutting back of old trees is usually followed by disappointment in the results obtained, and it is often a question as to whether this is worth while, although old trees, if not too far gone, may be restored to a more or less vigorous condition by judicious pruning. When elm branches a foot or more in diameter are topped nothing but a bushy growth results. By removing all but a single sprout much better growth may be obtained.

There is a difference of opinion as to the best time to prune, some authorities advocating spring and others preferring the fall of the year. Many people prune when the tree is in foliage; for example, in May or later. There are advantages in pruning in either season. Since trees occasionally bleed when pruned in early summer the painting of wounds is not always so successfully accomplished under these conditions; while, on the other hand, scars on vigorous trees are likely to heal somewhat during the summer if the pruning is done early.

THE TREE WARDEN'S OUTFIT.

E. A. START.

In some towns the tree warden has the actual work on the trees done by contract. When this plan is followed care should be taken to have a contractor who is competent and responsible. Tree butchers are plenty. Expert tree workers are very few. When the work is done by men employed by the town, under the supervision of the warden or his deputies, it is necessary to have a serviceable equipment. The following list is suggested for a beginner. More of some of the articles will be needed when much work is to be done.

	Approximate Cost.
1 30 foot extension ladder (to be kept well painted),	$6.00
2 pairs climbing irons (medium length leg iron and straps,	4.30
Only to be used where ladders are impossible, and never to be trusted to irresponsible men without supervision.	
3 16-foot Waters or Standard pruning hooks,	3.75
1 one-man cross-cut saw,	1.90
2 narrow blade carpenter's hand-saws, coarse,	2.00
2 half-inch augers and handle (for bolt work),	1.50
1 1¼ in. gouge (for cleaning cavities),	.75
1 1¼ in. framing chisel (for cavities),	.75
1 axe,	1.00
1 pole saw, bracket form, and six extra blades,	2.00
1 pole for above, 15 feet,	.25
1 framing mallet,	.45

1 carpenter's hammer (medium weight),	.40
1 machinist's hammer (for driving bolts),	.75
1 10-inch monkey wrench (for screwing up bolts),	.65
1 spade,	1.00
1 pair heavy tinsmith's shears (for cutting wire guards),	1.50
1 pair linemen's pliers (for putting up guards),	.90
1 50-foot hemp clothes-line (for hoisting tools, etc., into trees),	.25
1 100-foot ¾ in. hemp rope (for lowering large limbs, etc.),	3.15
1 stencil brush (for applying coal tar to cuts),	.25

In addition to these tools most towns need a spraying outfit in these days. When much work is to be done, the complete power outfits are the most serviceable and economical. They will cost $250 to $300. Smaller hand pump outfits can be obtained at from $25 up to $125, which latter figure is as low a price as will secure a really practical equipment for shade tree work.

TREE GUARDS.

E. A. START.

There are many tree guards on the market. A few are good, some are unhandsome and themselves disfigure the tree, and some are so attached that they cramp the tree and interfere with its health and growth. A tree guard should protect the tree to a height of about six feet, should be as light and inconspicuous as is consistent with strength and protection, and should allow the tree ample opportunity for growth. A neat and inexpensive guard used in Brookline is made as follows: Use No. 16 one-inch mesh wire, 32 inches wide. Cut a strip six and a half feet long. Cut through the mesh at the top of one of the twisted parts. This will leave one edge like A in Fig. 5, which is to form the top of the guard, and the other like B, which will be the bottom. Roll the wire in the opposite direction from that in which it comes to you. That is, lengthwise with the selvedge edge and fold the upper edge over close to the netting at the next twist. (See dotted line A, Fig. 5.) This must be on the outside, leaving a perfectly smooth surface on the inner side, so that there will be no danger of the tree being marred

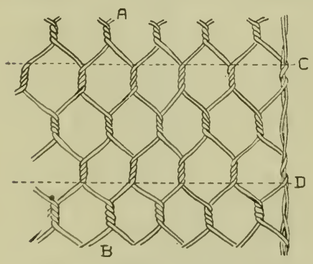

Fig. 5. Wire for tree guard.

by the cut ends in a high wind. The bottom edge can be unturned as it is to rest on the grass or soft earth. If it is to rest on a hard surface it looks better to finish at the bottom by turning the Λ shaped edges inward at the second row of twists. (See dotted line D, Fig. 5.) The upper edge can be curved a little outward (See Fig. 6), giving a more finished appearance to the guard. To fasten the vertical edges of the guard together when it is placed around a tree use No. 16 copper wire. Lap the guard to make it as small as is desired. Tie the guard at the top to the tree with stout soft twine in opposite directions to hold it in place. If this guard is made and set up in a workmanlike manner the result will be satisfactory and the expense moderate. Three men, one to cut and two to roll and bend the wire, can make and fit one hundred guards in a day.

A very cheap and efficient tree guard is used to quite an extent in some places, and is known as the "Clinton Tree Guard." This guard is made of No. 15 galvanized wire with a mesh ¾ inch in diameter, all the wire contacts being soldered. This wire can be bought in strips of various widths from 24 to 48 inches, and cut off any length desired, 6 and 6½ feet being the more desired lengths. Strips 12 inches wide or more are well suited for small trees. These are rolled up in cylindrical form of the desired diameter and tied together by one or two pieces of copper wire to prevent the top of the guard from chafing the tree. This may be made of pieces of rope or heavily insulated electric wire passed through the guard in such a way as to prevent the guard from coming into contact with the tree.

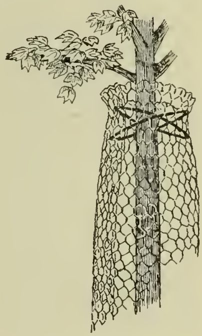
Fig. 6. The Brookline tree guard.

The great advantage of this guard is its cheapness, and since it is made of heavy wire and firmly put together it answers the requirements well. This wire is made by the Clinton Wire Co., Clinton, Mass., and costs about 4½ cents per sq. foot.

TREE SURGERY.

G. E. STONE.

The term "tree surgery" is a legitimate one to use in describing modern methods of treating trees, as they are similar to those used in human and animal surgery; that is, the treatment of trees is based upon aseptic and antiseptic methods. In the same manner that modern surgery is successful in correcting deformities, performing operations, etc., so a young and vigorous, although often imperfect tree, may be improved and rendered more valuable by the use of the same methods. While old and decrepit trees are often treated to extend their period of usefulness, it should be borne in mind that it is more desirable to care for the younger, more promising trees, and it is only too apparent that if more attention had been given to the care of old trees at the proper time, they would never be in the condition in which we often find them.

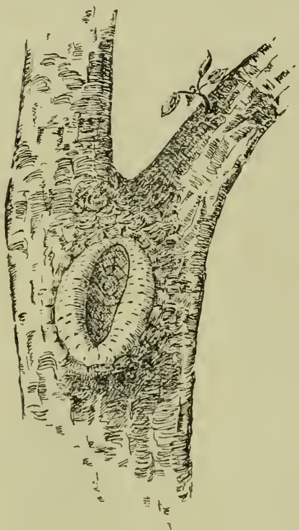

Fig. 7. Showing healing of wound. Most active healing follows most direct lines of transference of plastic materials.

Unlike the surgeon, who has no choice of subjects, the tree expert can select his individuals at the start and eliminate the imperfect specimens, although in the process of development trees need constant attention. It is desirable that antiseptic methods of treatment following pruning, mechanical injuries, etc., shall be adopted.

HEALING OF WOUNDS.

A protective feature characteristic of all plants is well illustrated in the healing of wounds. The healing tissues (callus) in a tree are the cambium and adjacent meristematic cells located between the wood and the outer bark. The plastic substances which provide the material for growth and healing are manufactured in the leaf and are transferred through certain tissues of the inner bark (phloem) adjacent to the cambium to various parts of the tree. When the tree is girdled or the bark removed no growth takes place below the girdling because the channels of transportation are destroyed.

In some young plants the pith cells possess the power to form a callus, but such cases are rare and of little importance. The younger the tissue or organ the more quickly it will heal, providing other things are favorable, and vigorous trees will form a callus much more quickly than old or weak ones. The nearer wounds are to the plastic materials the more rapidly they will heal; for example, the upper part and sides of a cut as a rule heal the most rapidly because they are in more direct contact with the channels supplying plastic materials for healing. (See Fig. 7.) Cuts made near large leafy branches are more likely to heal quickly than those near small ones, for the reason that a larger amount of the plastic materials is available.

To facilitate healing, recourse is occasionally made to cutting the bark smooth around the stumps of the removed limbs, and it is also claimed that after the callus is well started a re-cutting of the surface stimulates it to grow faster. Moisture is said to stimulate the growth of the callus, and the old practice of covering the wound with a mixture of cow-manure, clay and lime has this object in view.

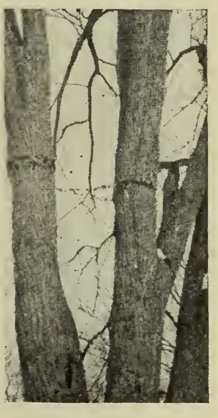

Fig. 8. Girdling by chain placed around tree.
From "Park and Cemetery."

In the pine family, whenever a wound is made it is quickly covered with pitch, one of the best substances for covering wounds, but for practical purposes coal tar is cheaper, and a thick coat of paint answers the purpose quite well.

Thick shellac dissolved in denatured alcohol has been recommended for painting wounds, and might be used to advantage. Coal tar is likely to injure delicate tissue, although this injury is not permanent. When paint and other substances are applied to limbs when they are moist and show a tendency to bleed, the results are not always satisfactory, and cases have been known of decay occurring even when coal tar has been used. The principal object in painting exposed wounds is to prevent the entrance of destructive organisms, and particular care should be exercised in doing it.

CHAINING AND BOLTING TREES.

In many instances it is necessary to render trees more secure by bolting or chaining them to prevent injury and disfiguration, and as this process is not an expensive one it should be much more largely used than it is, since many valuable trees have been rendered practically worthless by the loss of large limbs during wind storms. The elm, although a tough tree, with wood extremely difficult to work up into fuel, is very likely to split, and for this reason it is advisable to chain and bolt elm trees which show a tendency to weakness.

Fig. 9. Iron band around limbs of tree. An objectionable method. From "Park and Cemetery."

Different devices are employed for strengthening trees. Some of these are objectionable and do more harm than good; for instance, it has been common in many places to chain limbs to prevent their splitting, but as the tree develops the chain becomes imbedded in the bark, partially girdling it and disfiguring the tree to quite an extent. (See Fig. 8.)

Another equally objectionable method is placing strong bands of iron around limbs. (See Fig. 9.) Many prefer to use an iron rod rather than a chain, and although both have their place, in our estimation the chain system is the better for most purposes. If it is desired to secure rigidity by fastening the limbs near the point of forking an iron rod is preferable; but for long spaces remote from the junction of the limbs the chain method is superior, since a rod is likely to break owing to its rigidity when the tree is swayed by the wind; whereas a chain, which is flexible, will stand the strain better. Steel chains are stronger than iron rods, and for this reason are better for use in such cases, besides being easier to place than a solid rod, as less attention has to be given to boring the holes. If links are placed in the rod, as is sometimes done, this difficulty is of course obviated to some extent.

In most cases of chaining and bolting the washer and nut are placed on the outside of the bark, and often no attempt is made to cut the ends of the bolts off. The unsightliness of this method makes it objectionable. It is better to cover the nut and washer, which may be done by countersinking them into the wood of the tree, imbedding them in cement. (See Figs. 11 and 12.)

Fig. 10. Chain and bolt method of supporting imbs. From "Park and Cemetery."

By the aid of an extension bit a hole is bored through the bark into the wood, and the washer and nut are placed in this depression. They should be well imbedded in thick paint or tar and either elastic or Portland cement used to cover them, allowing the cement to come flush with the exterior surface of the wood. By this method the end of the bolt, the washer and the nut are covered and the exposed wood treated antiseptically, with the result that no further injury to the tree takes place. The scar heals over in a short time, leaving no trace of the bolt.

TREATING DECAYED CAVITIES, FILLINGS, ETC.

Decayed cavities in trees are very undesirable, since the fungi and insects which are present extend their range of activity, causing decay and shortening the tree's life. Cavities result from poor pruning of limbs, the breaking off of branches and other injuries which are not followed by proper treatment at the time.

The treatment of cavities naturally involves some expense, but if a tree is of value, if only sentimental, it is worth treating. There are many trees which to the casual observer would appear to be of little consequence, but the associations connected with them may be highly cherished. Then, again, the location is often important. The tree may furnish shade which cannot be dispensed with, and even if old and decayed it is more satisfactory to treat it than to wait for a new tree to grow.


Fig. 11. Showing tree properly bolted, washer countersunk and imbedded in cement. From "Park and Cemetery."

The rationale underlying the cleaning and filling of cavities is similar to that in dentistry, and there is reason to believe that if the work is properly done and if antiseptic conditions are maintained the length of a tree's life may be extended.

For centuries trees have been treated in one way and another, and cavities have been filled with wood, brick, stone and other substances for many years, but as a rule this work has been very crude in nature, and has probably done little or nothing toward the prevention of decay. During the past few years, however, more attention has been given to the treatment of decayed cavities in trees, and many examples may be seen, although it must be confessed that as yet the work is in an experimental stage. It is too early to say what has been accomplished by the various methods of treatment.

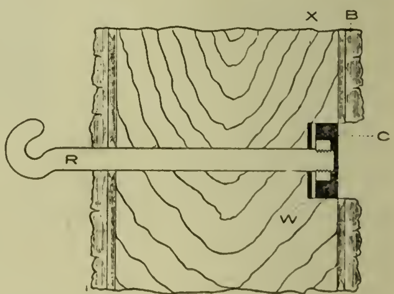

Fig. 12. Longitudinal section of limb, showing method of bolting. B, bark. X, wood. R, bolt. W, washer. C, elastic cement.
From "Park and Cemetery."

The object and process of treating decayed cavities may be summarized as follows:

First, to extend the usefulness of the tree and prolong its life.

Second, to remove all decayed tissue, which is done by a thorough cleaning out of the cavities.

Third, to treat antiseptically all those exposed tissues which are susceptible to decay, preventing further disintegration.

Fourth, to fill the cavity with some substance such as cement or to cover the surface with metal or other substance, in order that the callus may grow over the cavity and form a smooth surface.

Fifth, to strengthen the tree. This may follow immediately as a result of filling, or ultimately in the processes of growth, and sometimes is not accomplished at all.

Exposed tissues in cavities are treated with creosote or other substances to serve as an effective antiseptic. The cavities are filled with grouting composed of one part of cement to five parts of sand and gravel, over which is spread a coating one-half to one inch thick of one part of cement to two parts of fine sand. The grouting should be put in very soft, and the cement coating, which is put over the surface, should be soft enough to go on easily with a trowel. The grouting is kept back an inch or so from the surface of the wood. It can be held in place while soft by boards loosely fitted to the orifice of the cavity.

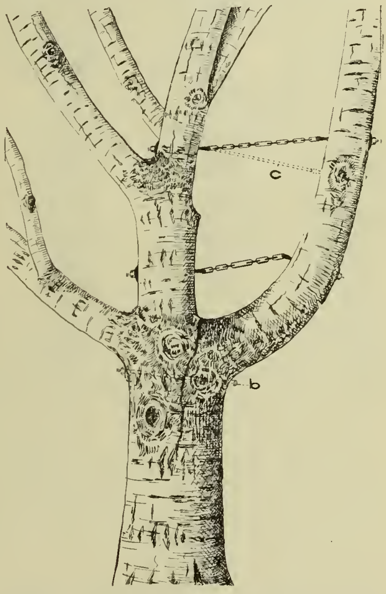

Fig. 13. Showing improper method of chaining tree. Dotted lines show more effective method. b, bolt. c, chain.

Many unsatisfactory fillings have been made by using the cement too dry, with the result that it possesses no strength. After the cement has been put in the cavity it should be well trowelled and kept moist for a few days. In all cases the cementing, when complete, should be flush with the wood and the cavity so shaped, when practicable, that it forms a wedge for the cement, thus preventing it from falling out.

Mr. John Davie, who has had large experience in filling trees with cement, in many of his fillings makes use of large iron bars. These are securely tied to the sides of the cavity for the purpose of holding the cement filling in place.

Occasionally a cavity is not entirely filled with cement, but a brick wall is constructed and the surface plastered with cement even with the wood, and in other cases the cavities are dug out, treated antiseptically, and covered with tin put on flush with the surface of the wood. Mr. H. L. Frost, of Arlington, has done some excellent work in tinning over cavities.

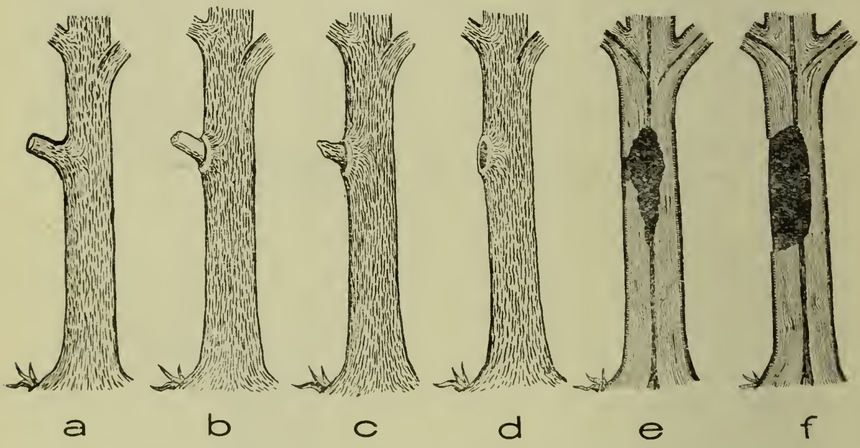

Fig. 14. Showing the evolution of a cavity and method of treating the same. a, long stub left from pruning. b, beginning of decay. c, more advanced stage. d, cavity formed in the wood. e, longitudinal section of the trunk showing cavity. f, cavity cleaned out and filled with cement.

Both the cement and tin methods have their defects. In the tinning method, changes in temperature may cause the tacks to become loosened, displacing the tin, in which case the callus grows under the tin, displacing it still more and defeating the object of the treatment. On the other hand, the cement is likely to crack on the surface and contract from the wood after drying, and in some instances adds too much weight to be supported when limbs are filled. This may be obviated by filling with some lighter substance or by tinning, and in some cases the weight has been supported in part by rods extending from the trunk into the limbs and imbedded in the cement.

The contraction of the cement from the wood leaves a space which is likely to become filled with water. In winter the space may open like a frost crack and decay set in in time, even if the wood is disinfected ; therefore, we have always found it important to have the cavities painted with some thick substance of an elastic nature to fill the space caused by the contraction of the cement. In this way the water is kept away from the wood and the danger of infection lessened.

Various kinds of fillings have been tried, also different substances for disinfecting cavities, but little can be said about their relative value at the present time. The writer has experimented with a variety of cements and disinfectants and prefers an oily substance to a watery solution for disinfecting a cavity. We have used creosote more than any other substance for this purpose, since its wood preserving qualities are well known, and so far as we have seen it causes no injury when applied to cavities.

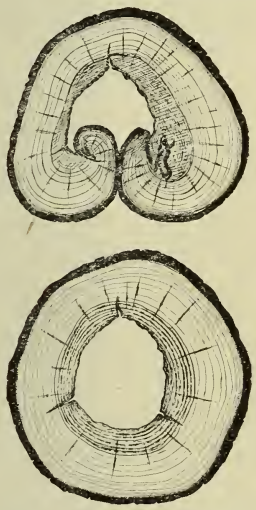

Fig. 15. Demonstrating the object of treating cavities. Upper figure showing cavity of long standing, with callus curved in, which, if it had been filled, would be as represented below.

One of the objections to the use of Portland cement in filling cavities, as previously mentioned, is its tendency to crack. Mr. John T. Withers, who has had much experience in filling trees, recommends re-inforcing the surface with wire. He has employed this method, and some of our best fillings have been re-inforced in this way.

The fillings in trees which are likely to sway considerably are sure to crack, and although the cracks formed are not often serious, this objectionable feature may be overcome by laying the cement in blocks or sections and filling in between each section with some thick elastic substance to keep out the water. Such substances as thick coal tar, coal tar and roofing tar mixed, or slaters' cement would answer this purpose.

Some attempts have been made to sculpture the surface of the cement to imitate the bark, but this is objectionable from many points of view.

The cost of filling or tinning trees need not be excessive nor beyond the reach of most individuals or towns. Considerable experimenting and careful observations, however, must be made in order

Fig. 16. Showing cavity in valuable yellow oak being prepared for filling.

to ascertain the best method of treating cavities. Most of the cleaning of the cavities at the present time is done with mallets, chisels and other tools, but a rotary cutter driven at high speed by a gasoline engine or other power would greatly facilitate this work, and we are now experimenting with such a machine.

EFFECTS OF GAS, ELECTRICITY, ETC. ON TREES.

G. E. STONE.

INFLUENCE OF ILLUMINATING GAS.

Undoubtedly a larger number of trees suffer from the effects of escaping illuminating gas in the soil than formerly. The increased

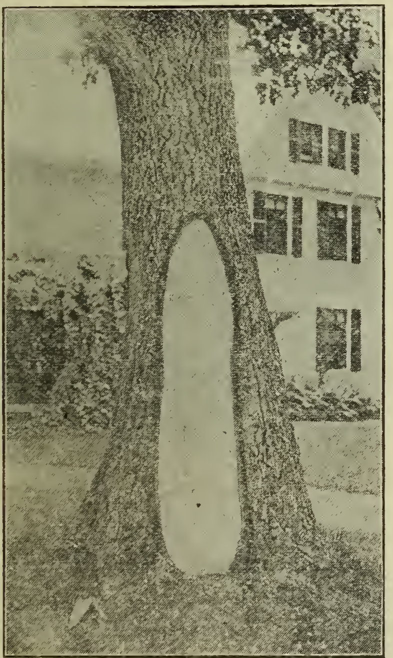

Fig. 17. The same cavity properly filled with reinforced cement.

death rate from this cause may be accounted for by the fact that gas is now more extensively used, and the larger pipes and different types of connections now in use, together with the modifications in the methods of laying and calking the joints are no doubt responsible for the increase; at any rate, it would seem that when small pipes have been in the ground for many years with thread joint connections, there is much less leakage than if larger pipes are used and the calking done with oakum and cement or lead.

The trolley, steam roller and other heavy traffic on highways are in part responsible for defective joints, and occasionally cause leakage of gas. The continual excavation and undermining of gas conduits made necessary by the construction of sewer and water lines, as well as the effects of frost in severe seasons, also cause leakage, and finally the modern network of wires, steel rails, etc., which carry electricity, are a constant source of danger to gas pipes, as is occasionally proved by cases of electrolysis.

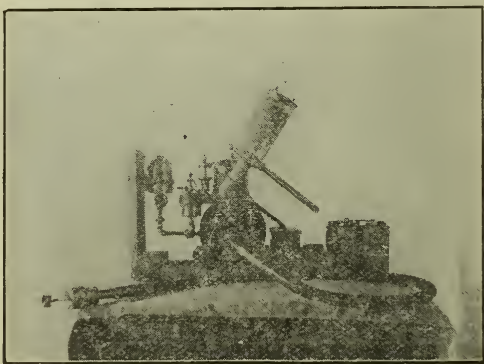

Fig. 18. Showing flexible shaft and gasoline engine arranged for cleaning cavities.

A large amount of the gas manufactured is unaccounted for. According to the twenty-first annual report of the Gas and Electric Light Commissioners of Massachusetts, the production of gas for the year 1905 in this State was 6,418,024,954 cubic feet. The amount unaccounted for during that year was 622,304,044 cubic feet; in other words, there was a loss of about 10 per cent. This loss undoubtedly represents more than mere leakage, however, since part of it may be accounted for by differences in temperature to which the gases are subjected when measured.

It should be stated, in justice to many of the larger manufacturers of gas in this State that every effort is made to prevent leakage and injury to trees, and some of our more progressive gas manufacturers spare no expense or skill in constructing and maintaining their lines. In laying the larger pipes, which are more difficult to keep calked securely, they are providing their patrons with better facilities; nevertheless, they run a greater risk from leakage.

Numerous connections are found in gas mains from which can be detected only slight leakage, perhaps only a few cubic feet a day; whereas there are others from which the leakage is extensive. The presence of small leaks, if not attended to, will injure trees in the course of time, since the soil becomes charged with gas

Fig. 19. Large elms killed by escaping illuminating gas, one and one-half years after leakage occurred. From "Park and Cemetery."

to a greater or less extent in a few years.

In the eastern states the three principal kinds of gas used are water, coal and oil gas, and so far as the effects of these various gases on trees are concerned there is apparently little or no difference, since they all contain similar elements which are poisonous to trees.

Two degrees of injury may readily be distinguished as resulting from gas poisoning; first, incipient cases, and second, pronounced cases. In the first series we have those already alluded to as resulting from small leaks, the soil in such cases not becoming saturated for any considerable distance. Such leaks may not result in killing the tree directly but cause it to be unhealthy and shorten its life, and there is likely to be an unusual amount of dead wood annually found on such trees. Occasionally a large tree may be located near a small leak, when only a single root will be affected, but those portions of the trunk of the tree in direct connection with that root will show the effects of gas poisoning. Small leaks of this description often produce only local injury but trees affected in this manner may suffer with what is termed "general debility," a term often used to conceal a vast amount of ignorance concerning diseases in general.

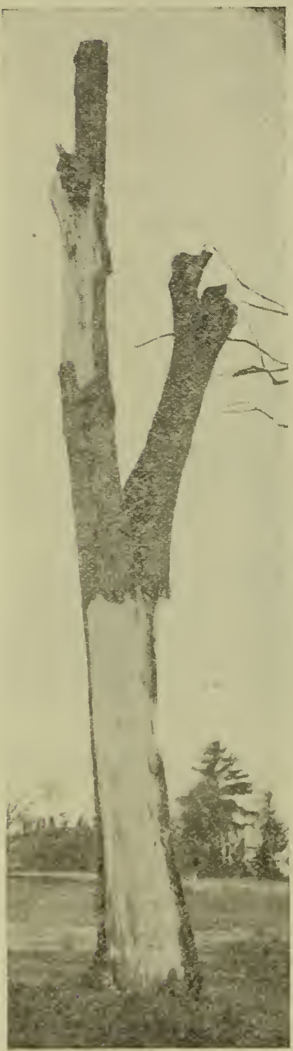

Fig. 20. Showing effects of illuminating gas on elm tree one and one-half years after leakage occurred. From "Park and Cemetery."

In severe cases of gas poisoning such as take place where there is a large leak the effects on a tree are very pronounced, and there is absolutely no hope of recovery for a tree which has once been severely injured. If a tree has been defoliated, or even half defoliated, from the effects of gas there is little or no hope for it. There appears to be little difference in the susceptibility of different species to gas poisoning, but trees with a large spread of roots are more likely to be affected than those with a limited spread.

The characteristic symptoms of gas poisoning are quite distinct to one familiar with them, and can generally be distinguished from other troubles which are likely to affect a tree.

One of the first effects in summer is a yellowing of the foliage, followed by a greater or less defoliation of the tree, according to the degree of poisoning. The trunk of the tree generally assumes a dark color, indicating an absence of life, but this feature is not always noticeable. The sap wood is often found to be discolored, and it has peculiar, characteristic odors which assist in diagnosis. Sometimes, however, especially when the tree is injured by gas in late summer, at which time the flow of sap is not so active as it is in the spring, the odors of the wood are not so marked. Where slow poisoning occurs this same condition of the tissue is noticeable. If only one root becomes affected with gas, that portion of the tree nearest it will show the effect first. Generally, however, the top of the tree first shows the effects by defoliation and loss of bark. The presence of fungi on trees (Schizophyllum, Polystictus, etc.) affected by gas is of common occurrence and often significant, and they frequently make their appearance shortly after a tree has been injured. Trees affected by gas disintegrate very rapidly, and should never be allowed to stand long after dying, as they become brittle and are a source of danger.

Fig. 21. Showing the destructive effect of wires on the growth of trees.

Gas escaping into the soil from a leak follows the line of least resistance. For this reason, if leakage occurs in the street in front of a house one can usually detect the odor of gas in the cellar, as the gas will follow the exterior of the pipe leading into the cellar, and it often escapes into sewers, underground conduits, hydrants, etc. There is considerable difference in the resistance of soils to gas. In gravelly soils we have known gas to travel 2,000 feet when the ground was frozen and escape into the cellar of a house, whereas in heavier soils gas is more likely to be restricted to smaller areas.

The poisonous properties of gas are undoubtedly due to coal tar products, which contain such compounds as sulfates, cyanides, etc. More or less of the gas and its constituents is absorbed by the water in the soil, and these are taken up by the roots and translocated to various parts of the tree through the sapwood, and when they come

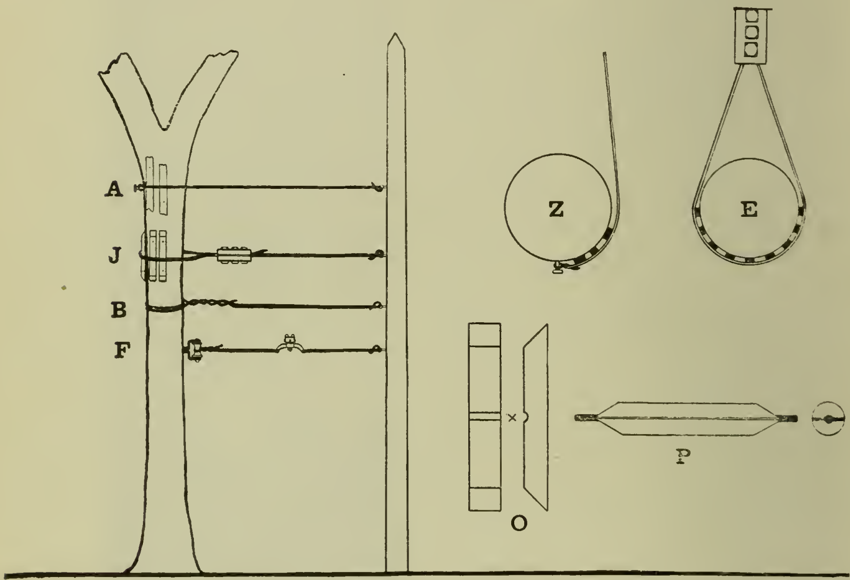

Fig. 22. Showing methods of attaching wires to trees. A, wires attached to lagbolt and protected from tree by stick. Z, section of the same. B, wire loop placed twice tightly around tree, causing girdling. J, loose wire loop fastened with clamp and separated from the tree by blocks. E, cross section of the same. O, section and surface views of blocks. x, groove for wire. F, showing attachment of trolley guy wires. P, wooden sleeve for wires to protect from burning. From "Woodland and Roadside."

into contact with living tissues destroy them. The feeding roots are naturally first affected, and in a brief period of time the larger roots and trunk near the surface of the ground will show the effects of poisoning.

About 1 or 2 per cent. of gas is absorbed by water, and the water in the soil becomes saturated to a certain extent. In the course of time, when the leakage is more or less extensive, the odor of the soil becomes extremely obnoxious. This odor disappears very quickly when the soil is aerated, and when a gas leak is repaired it is an excellent idea to leave the ditch open for a few days to get rid of the strong odors which are present in the soil. There is a certain capacity for adaptation in plants to poisons, which probably exists to some extent in the case of trees affected by gas, but this capacity is limited, and if the leakage of gas is continuous the roots are sure to be poisoned in time. It requires a considerable amount of gas to kill a large tree, but it must be borne in mind that the conditions surrounding a tree are favorable for maintaining gas in the soil for a long time. Certain devices may be employed at no great expense when installing a system of lines which will readily detect sources of leakage and prevent gas escaping into the soil, thus preventing injury to trees. There are many instances where the cutting of roots under a roadbed, which is necessitated by regrading and placing curbing, has saved trees from injury from gas poisoning, and the presence of conduits near leaks has been known to prevent injury to many trees.

Fig. 23. Showing burning caused by alternating current wire.

If symptoms of gas poisoning are discovered in only one root, and the poisoning has not extended to the tree trunk, amputation of the root is the best remedy.

EFFECTS OF WIRES ON TREES.

During the last few years a very material increase in the number of electric and telephone wires used has been the means of ruining the appearance of many beautiful streets, and of all the troubles with

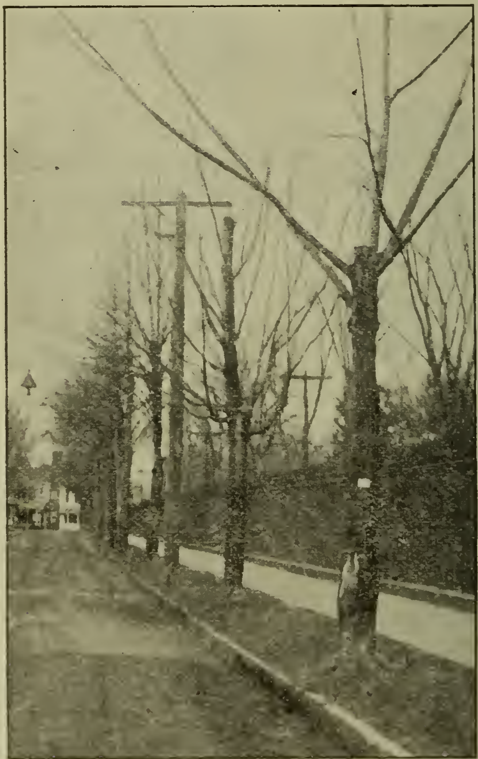

Fig. 24. Showing disfigurement of trees caused by burning from electric wires.

which tree wardens have to contend the wire problem is often regarded as the worst. Notwithstanding the strict laws which some states have adopted in regard to injuring shade trees, the agents of some public service corporations have little regard for trees or the laws protecting them.

In the case of telephone wires, the cable system may be used and much injury to trees prevented in this way. Large cables are rather expensive to install, but what is called the "ring construction" system may be used to advantage in many instances, particularly in the suburbs. In this way it is possible to run a line through avenues of fine trees in the country districts without necessitating pruning or disfiguration. In cities and larger towns the proper solution of this problem consists in burying the wires in conduits, and although this is somewhat expensive it is being done more and more each year. It is often quite useless to start an avenue of trees under a mass of wires with the expectation of making them thrive. In many cases permission has been given to install poles and wires on private property, and in this case it is necessary for the abutter to give the company right of way for an indefinite period of time.

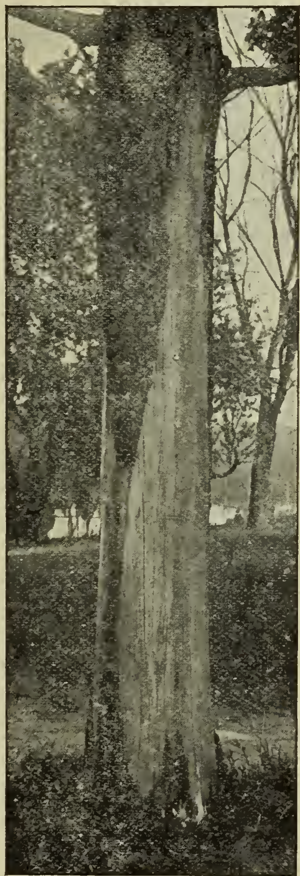

Fig. 25. Showing maple tree killed by direct current from trolley system.

So far as trolley wires are concerned, the conduit system is out of the question in the smaller towns at present on account of cost, but electric lighting wires may often be run over private property in the rear of houses, or buried in conduits, much to the advantage of the trees and streets in general.

In cities high poles are occasionally used, the wires being placed as far above the streets as possible, which prevents considerable damage, particularly to young and middle aged trees.

On general principles it is not wise to allow wires to be attached to trees, although this is often done. Trolley and electric light wires are frequently guyed to trees, but they are a source of danger,

Fig. 26. Showing ridge on tree, caused by feeble lightning discharge.

since by the crossing of the wires injury is likely to occur, and lightning discharges occasionally pass from the wires to the tree, causing damage. It is, however, often better to allow the wires to be attached to trees than to endure the addition of ugly poles, but if wires are to be attached to trees they should be properly insulated, although ordinary insulators have little effect on lightning discharges. The lagbolt system in common use (see Fig. 22, A and Z) for guying wires to trees is not the best method of attachment, since sooner or later the wire and bolt become imbedded in the tree and cause injury. The block system (J and E) is better, although it may not be in all cases free from objections. In no case should a wire be allowed to pass tightly around a tree (B), as it will girdle it in time. When live wires come into contact with limbs some type of insulator should be employed similar to that shown in P. The porcelain and dowel insulator gives good satisfaction.

Wires often accidentally come in contact with trees by the displacement of poles, particularly on curves, where the strain is very great, but much of this injury may be prevented by imbedding the poles in Portland cement, and it should be pointed out that the necessity for guying poles to trees may be obviated in this way.

ELECTRICAL INJURIES.

Alternating Currents.

Electrical injuries, such as are caused by burning, are common to trees, and occasion tree wardens a great deal of vexation. There are many instances of large limbs being burned off, and in some cases the burning is so extensive that the whole top of the tree is injured. There are, however, no authentic cases of an alternating current completely killing a tree, and the injuries caused by this current occur only during periods of moisture, when there is a grounding. Owing to the high resistance of trees it would require an exceptionally high potential to furnish sufficient current to kill a tree even if wires were inserted into limbs and roots and the current allowed to pass through the tree. In all cases, so far as has been observed, the injury resulting from alternating currents is due to burning.

When grounding takes place leakage occurs, causing burning and steaming which, if the contact continues, will cause a blaze and burn a deep hole in the limb. Sometimes a tree may be injured a few feet above and below this burning, but it never extends to the base of the tree. Occasionally the grounding is so marked that it is dangerous for one to come into contact with a tree, and a person standing on the ground and touching his fingers to the leaves would receive quite a severe shock.

During periods of damp weather neither rubber nor porcelain insulators prevent leakage in high tension wires; consequently, when even insulated wires are brought into close contact with trees some escape of the current takes place. Injuries to trees often occur when alternating current wires during storms accidentally come in contact with other wires attached to trees. For this reason there is always risk, as has already been pointed out, in allowing any wires to be attached to trees.

Direct Currents.

Direct currents of electricity are chiefly employed by electric railways, although occasionally used for lighting purposes. A direct current appears to have a different physiological effect upon, and is more disastrous to protoplasm than an alternating current, since it causes disintegration of the cells, and there is reason to believe that a direct current is capable of killing a tree even if the strength of current is not sufficient to cause burning.

The direct current, like the alternating, causes injury to trees by burning, and there are instances known where it has killed trees. In some instances the base of a tree has been girdled to a distance of ten feet or more from the effects of direct currents from trolley lines, and in such cases the trees have died from electrocution.

LIGHTNING.

Lightning affects trees in different ways, the most common effect upon vegetation being a shattering of the tissues. It is surmised that some trees are more susceptible to lightning strokes than others, but little is known about the subject.

A stroke of lightning is frequently dispersed in such a way as to travel over more or less of the cambium zone of the tree, thus girdling it and causing its death, and trees have been observed which were killed instantly by a lightning stroke but which showed no fracturing whatsoever, in which case the lightning, although not powerful enough to dislocate any of the bark, had destroyed a considerable portion of the vital layer of the tree.

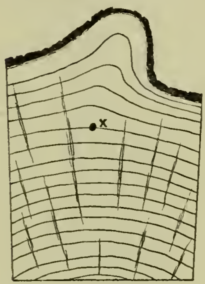

Fig. 27. Cross section of a piece of wood taken from a tree struck by lightning, showing the formation of ridge on the outside of the bark. x, small dead area corresponding to path of lightning discharge.

More frequently, however, trees receive only a slight discharge, which burns out a very small hole near the cambium, and the result of such a discharge will not be noticeable until two or three years afterward. In such cases a ridge forms on the bark, revealing the path of discharge. An examination of the tissue will disclose a small hole, usually not larger than the head of a pin, running down near the cambium layer. A wound of even this size acts as a stimulus and induces a marked growth of the cambium. These cases are very common but often overlooked.

Less common, are earth discharges, which originate in the soil and discharge from the limbs, but there are enough authentic cases to prove they occur, and they occasionally cause injury. It is known that a great difference frequently exists between the electrical potential of the earth and air during thunder storms, and that the electrical conditions of the clouds and earth may change instantly from negative to positive. It is then that earth discharges may take place.

INSECT ENEMIES OF SHADE TREES.

H. T. FERNALD.

It is impossible to adequately consider in detail even the more important pests of shade trees within the limits here assigned. Over five hundred different insects feed on various kinds of oaks; the elm, maple, evergreens and other important trees each have many enemies; and a few general remarks and a more detailed consideration of the most important insects is all which can be given.

Two fundamental principles underlie methods of treatment. For insects such as caterpillars and others which feed on the leaves, spraying with arsenate of lead is usually a success, though if the feeding is not noticed until the insects have nearly finished their work, the results will hardly be satisfactory. Where the insects are feeding in clusters, it is often cheaper and easier to gather the clusters by hand and destroy them than to spray; and there are some leaf feeders whose habits are such that neither hand picking nor spraying is the best method of control, and special treatment for each case is necessary.

For insects which do not feed on the leaves, but suck the juices, arsenate of lead is useless, as such forms get none of the poison into their bodies. Accordingly, something which kills every insect it touches, and which is called a contact poison, is used instead. Kerosene and soap are most often used in this way, and directions for making a few of the most successful sprays are given at the end of this article.

In general then, if caterpillars, grubs or insects in any stage are eating the leaves, spray with arsenate of lead if they are scattered, or pick them off if they are in clusters; for sucking insects, like plant lice, scales, etc., spray with a contact poison.

Failure to observe three points is responsible for nine-tenths of the poor results from spraying. These are: 1. Be sure the spray material is properly made. 2. Apply thoroughly. 3. Apply at the right time.

THE ELM-LEAF BEETLE.

(*Galerucella luteola* Müll.)

A European insect which reached this country about seventy-five years ago. It is generally distributed over Massachusetts, though it may perhaps rarely prove to be a serious pest in certain of the higher and colder portions of the state. It passes the winter as the adult beetle in attics, unused chimneys, outhouses, barns, etc., and about the time the elm leaves develop in spring, leaves its winter

Fig. 1. Elm-Leaf Beetle. a, eggs ; b, larvæ ; c, adult ; e, eggs ; g, larva ; j, pupa ; k beetle ; a, b and c, natural size ; e, g, j and k, much enlarged. From U. S. Department of Agriculture.

quarters for the trees. At such times, the beetles often gather on the windows of houses mutely pleading to be let out, and causing housekeepers to fear that they will have an army of carpet beetles, or some other household pest, to fight. Flying to the trees, the beetles eat irregular holes entirely through the leaves and lay their eggs in clusters of a dozen to about thirty, on the underside of the leaves, feeding and occasionally depositing eggs in this way for several weeks. The grubs which hatch from the eggs feed on the leaves, but leave the upper surface entire, and become full grown in from fifteen to twenty days. They then go to the trunk, and most of them crawl to the lower part or to the ground at the foot of the tree, where they change to the adult beetles, about a week being required for this purpose.

In most seasons these beetles pass the winter before laying the eggs for the next generation, but in some cases a new brood, which feeds during the late summer, is met with. Fortunately, this is not usually the case in Massachusetts.

To keep this pest in check, spraying the trees thoroughly with arsenate of lead when the adult beetles appear on them in spring is the best treatment, followed by a second spraying when the grubs hatch—about the tenth of June would be an average date for this state,—spraying upward as much as possible to place the poison on the underside of the leaf where the grubs feed. Unfortunately, financial considerations usually prevent two treatments of this kind, and the usual practice is to omit the first spraying and begin the other about the first of June. Later, when feeding has ended and the grubs and pupæ are on the trunk and on the ground at the foot of the tree, spraying these with kerosene emulsion, or treating (not spraying) with hot water, will destroy them, though if the tree be young and with thin bark, the hot water may injure the tree, and the emulsion should be used in such cases. Treating the insects on the trunk and ground, of course, does not help the tree any at the time, as the injury has all been done, but it will at least reduce the number of insects which would attack the tree later. Sticky bands around the trunks are almost worthless against this insect.

THE WHITE-MARKED TUSSOCK-MOTH.

(*Hemerocampa leucostigma* Abb. & Sm.)

This common insect attacks many of our shade and fruit trees, and is everywhere abundant in Massachusetts. The winter is spent in the egg stage, the eggs being found on the old cocoons from which

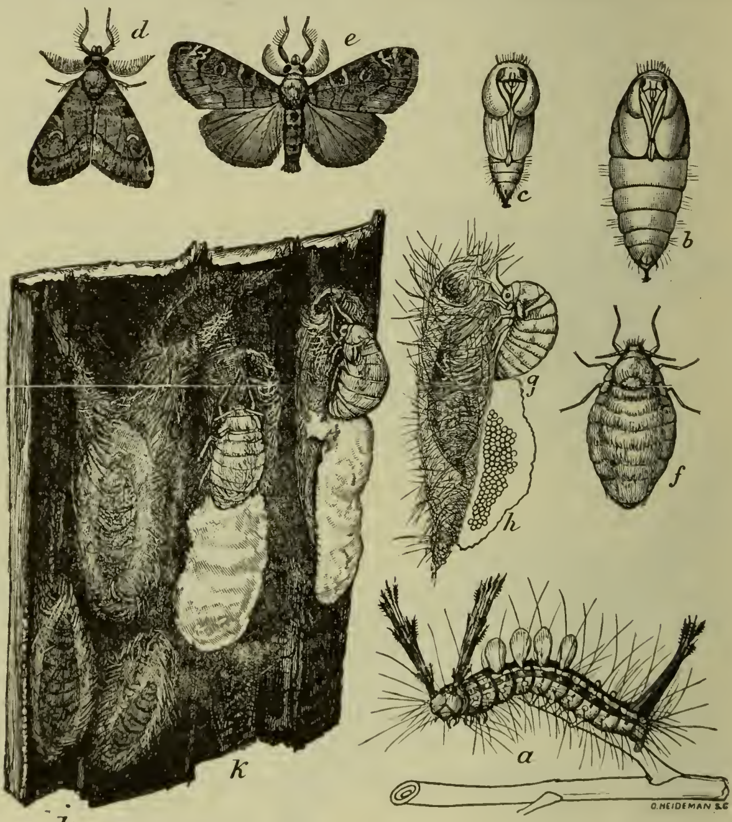

Fig. 2. White-marked Tussock Moth. a, caterpillar; b, female pupa; c. male pupa; d, male moth; e, same, wings spread; f, female moth; g, female moth on cocoon; h, egg mass with froth over it; i, cocoons on tree trunk; k, same, showing females and egg masses also; all slightly enlarged.

the moth laying the eggs emerged. The eggs are in clusters and covered by a white froth, which hardens to a sort of crust, concealing them.

These eggs and the old cocoons to which they are attached may be found on the trunks and limbs of the trees, or on objects nearby.

Occasionally, the cocoons are attached to the smaller twigs, and in such cases a leaf is usually involved, making these places more noticeable during the winter.

The eggs hatch in the spring and the caterpillars feed on the leaves, becoming full grown in June. They then go to the trunk or larger limbs, where they spin gray cocoons from which the moths emerge in July.

The female moths, being without wings, remain on the cocoons from which they emerge and there lay their eggs, covering them with white froth as already described for the preceding brood. These eggs soon hatch and the caterpillars climb to the leaves and feed until the middle or last of August; then, when full grown, return to the trunk or larger branches to make cocoons in their turn, the moths from these emerging shortly thereafter and laying eggs, which remain through the winter before hatching.

This sketch of the life history shows that there are two broods of the insect each year, and consequently two periods of injury to the trees, the first being during the spring months and ending in June; the second being during July and August. When the caterpillars are so abundant as to strip the tree in the spring, the second brood will appear in time to feed on the new growth put out by the tree to replace that lost earlier, thus seriously injuring it by more or less completely defoliating the tree twice in the same year—a drain which no tree can successfully withstand for more than a year or two.

Treatment for the Tussock Moth may be of two kinds. If the caterpillars are already at work on the leaves, spraying with arsenate of lead is effective; but a simpler and cheaper method for their control is to gather and destroy the egg masses, this being made easier by the presence of the white crust over them, making them very noticeable, and by their location, nearly all being on the trunk and large limbs. Destruction of the egg masses should be in July as soon as they appear, and again at any time between the first of October and the last of April, and spraying should only be necessary if the destruction of the eggs has been neglected. Trees not infested can be kept clear, provided their branches do not touch those of infested ones, by banding the trunks with Tree Tanglefoot, for as the female moths cannot fly, such trees can only be reached by the moths or caterpillars crawling to them.

THE FALL WEB-WORM.

(*Hyphantria textor* Harr.)

The tents formed by the caterpillars of this insect are often very noticeable in the early fall months on various shade and fruit trees and often cover several square feet.

The moths, which are flying during June and July, greatly resemble those of the Brown-tail moth, but are without the golden brown tuft at the end of the body possessed by the latter. The eggs are laid in clusters on the leaves, and the caterpillars on hatching at once begin to spin a web under which they feed. As this proceeds the tent is extended until it may cover the surface of an entire limb, greatly injuring the appearance of the tree, and when the webs are numerous entire trees may be covered and stripped of their foliage. After about a month's feeding the caterpillars crawl to protected places where they spin cocoons in which they spend the winter.

This insect is rarely so abundant as to endanger the life of a tree, but its webs are so noticeable in August and September that treatment is very desirable to keep the insects under control and the trees looking well. When the webs first appear it is easy to remove them by hand and crush the caterpillars. When they are so located as to make this impossible, and also when they have become so large as to prevent this, spraying heavily with arsenate of lead around the web is of service, for while the leaves actually fed upon are protected from the spray by the web over them, any subsequent enlarging of this to enclose more food will result in bringing the sprayed leaves under the web, where they will be consumed.

CANKER WORMS.

(*Alsophila pometaria* Harr., the Fall Canker-worm.)
(*Paleacrita vernata* Peck., the Spring Canker-worm.)

Though canker worms are very common in Massachusetts, they only become destructively abundant at intervals of several years, and though both the Fall and Spring Canker worms occur it is probably the former which is most frequently met with.

The two kinds have many features in common. The caterpillars of both feed during the spring months; both transform from the caterpillar to the adult in the ground; the female moths of both are wingless, and in both the eggs are laid on the twigs. These facts are of importance for the successful treatment of both pests.

The fall canker worm moths come out of the ground late in the fall and the female moths crawl up the trunks of trees to the twigs, where they lay their eggs. The eggs do not hatch until the following spring, when the tiny caterpillars (inch worms, measuring worms or loopers, as they are variously called), begin feeding on the newly developed leaves. By the middle or end of June feeding has been completed and the caterpillars, now an inch or more in length, either crawl down or spin down a thread to the ground, which they enter and where they transform to the moths which will appear late in the fall.

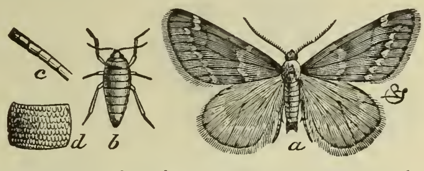

Fig. 3. Fall canker worm. a, male moth ; b, female moth ; c, d, structural details.

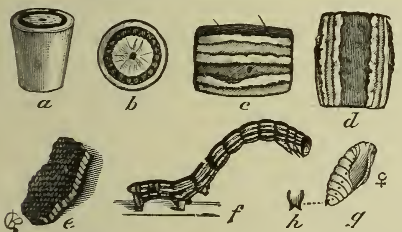

Fig. 4. Fall canker worm. a, side view of single egg ; b, top view of same ; e, egg mass, natural size ; f, full-grown caterpillar ; c, d, g, h, structural details.

The spring canker worm moths come out of the ground during the first warm spring days, and like the others crawl up to the twigs, where they lay their eggs. These soon hatch, however, and the caterpillars feed during the spring at the same time as do those of the fall canker worm, and also complete their feeding at about the same time. They then enter the ground to transform, but do not leave it for the trees the same year, waiting until the following spring.

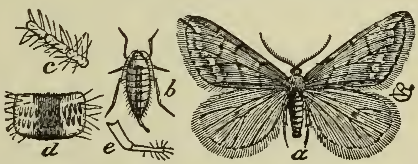

Fig. 5. Spring canker worm. a, male moth b, female moth ; c, d, e, structural details.

The first year canker worms become so abundant as to be noticeably destructive it is probable that the earliest knowledge of this will be obtained from the appearance of the leaves where the caterpillars are at work. In such cases, spraying with arsenate of lead is the only treatment available. Thereafter, however, other methods for their control are preferable and should be made use of.

The fact that the females lay their eggs on the twigs; that they come from the ground; and that being wingless, their only way of reaching the twigs is by crawling up the trunk, point to the treatment, which is to band the trunks of the trees with an adhesive such as Tree Tanglefoot. This should be applied in September for the fall canker worm and be kept fresh until winter, one application usually being sufficient. For the spring canker worm, the tanglefoot should be applied on the first warm day—sometimes in February, generally in March—and be kept fresh until the middle of May. If this treatment be carefully made, no trouble from canker worms need be feared.

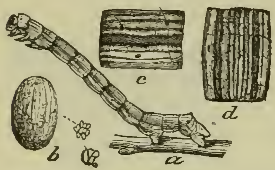

Fig. 6. Spring canker worm. a, full-grown caterpillar; b. enlarged egg and part of a mass, natural size; c, d, structural details.

SPRUCE GALL LOUSE.

(*Chermes abietis* L.)

This tiny plant louse forms galls at the bases of the twigs of various kinds of spruces and seriously injures the trees. Old, dry galls with open cavities in them remain on the tree for years after they are formed and the new ones, which are green, occasionally with pinkish marks, appear in June and July. In these galls the lice feed until August, when the galls begin to turn brown and the cavities within crack open, allowing the insects to escape. During the remainder of the year, the insects in various stages may be found on the tree but are not in galls.

The formation of a gall at the base of a twig almost always results in the death of that twig, so that when these insects are abundant the tree, instead of being thickly covered with foliage, becomes thin, with many dead twigs, and, as a whole, is far from being the ornament it should be.

There are two methods by which the attacks of this insect may be reduced. If the tree has only recently become infested, the galls will be few in number, and may be picked off and destroyed during June and July. If they are too abundant for this to be practicable, spraying very thoroughly in April with one pound of whale-oil soap dissolved in two gallons of water has proved effective.

COTTONY MAPLE SCALE

(*Pulvinaria innumerabilis* Rathv.)

This scale insect is frequently a very serious enemy of soft maples and is often present in smaller numbers on other maples, elms and other plants. It is found on twigs and looks like a small mass of cotton, protruding at one end from beneath a brown scale.

During the spring months before the cottony portion has developed, this insect is not very noticeable, but by the end of June and during the two months following the cottony threads among which the eggs and young are found, make it a prominent object.

The young soon leave the cotton where they were born and wander to the leaves where they settle down, generally along the veins, and each secretes a covering scale. Shortly before the leaves fall they migrate from them to the twigs, where they spend the winter. In the spring they grow rapidly and produce large quantities of honey dew, which adheres to and dries on the leaves or twigs on which it may fall. In June the cottony threads are produced and the insect then becomes more noticeable.

Brushing the infested limbs and twigs with a stiff brush wet with kerosene emulsion has been recommended as a treatment for this insect. The most successful results, however, have been obtained by winter spraying with eighteen to twenty per cent. kerosene emulsion. This may be made by mixing three gallons of the stock emulsion (see directions for making at the end of this article) with about seven and a half gallons of water.

BORERS.

Almost every kind of tree and shrub seems to be attacked by borers, and as their work is inside the stem to such a large extent, successful treatment is often very difficult. As it is impossible to consider the different borers separately here, a few general suggestions are all which can be given on this subject.

In nearly all cases, the eggs of the borers which work in the trunks are laid on the bark. Accordingly, anything covering the bark which will prevent egg laying without injuring the tree will be useful if applied at the proper time. Sometimes, soaping the trunk for this purpose is of value; whitewashing the trunk frequently induces the insect to leave trees thus treated, for others ; and wrapping in tar paper is also of value. Careful examination of the trunk and ground will sometimes show where borers are at work, little accumulations of " sawdust " being evident. In such cases, it is frequently possible to cut out the borers, or to run a flexible, pointed wire into the tunnel and spike the borer at its end. Sometimes a little cotton saturated with carbon disulfid can be placed in the outer end of the tunnel and the opening then be closed either with putty or clay, permitting the disulfid gas to follow along the tunnel and suffocate the borer. In fact, the most important and difficult part of the problem is to find where to make the attack, and only careful examination in each case will solve this.

WHITE PINE WEEVIL.

(*Pissodes strobi* Peck.)

This insect bores in the leaders of pine, spruce and perhaps other evergreen trees, killing these shoots, deforming the tree, and of course greatly reducing its value as an ornament.

The beetles lay their eggs in the leaders during the spring, and the boring grubs work inward and downward until they reach the pith, in which they also burrow for a short distance. At first, an affected shoot shows little or no trace of the presence of the borer, but by midsummer it begins to turn brown. The borers change to pupæ and these to adults, which are found the following spring.

But little can be done to control this insect beyond cutting off and burning all infested twigs as soon as they show traces of infestation, thus destroying the insects before they leave.

SAN JOSE SCALE.

(*Aspidiotus perniciosus* Comst.)

While the San José Scale has attracted most attention because of its importance as a fruit tree pest, it is also of great importance as an enemy of many kinds of shade trees and ornamental shrubs. It often entirely destroys willows, poplars and mountain ashes, and is frequently abundant on the elm, ash, ornamental plums and crabs, etc., and to a less extent on the maple.

The adult insect is about the size of a pin head, and is covered by a dark gray or brownish scale or shell nearly circular in outline. In the early spring months only those from one-half to two-thirds grown are living and these become adult in June, beginning to produce young during the last half of this month. The young are born alive, a few every two or three days during the latter part of June and the month of July, and in their turn become adult in about a month at this time of year, and begin to produce young. These are very small

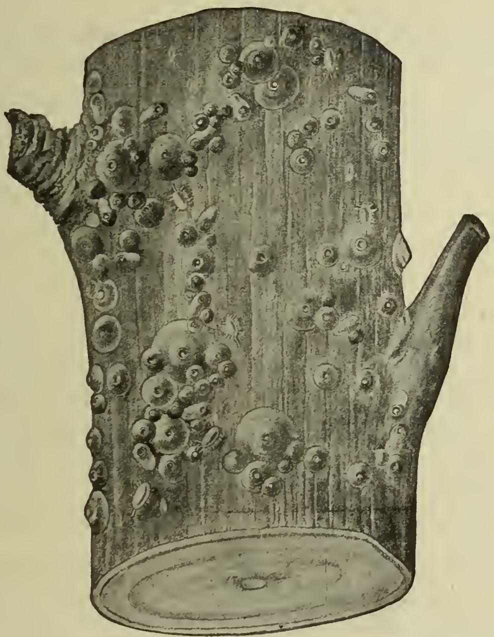

Fig. 7. San José scale; different stages, enlarged five times.

and lemon yellow in color. They crawl about for a short time, then settle down, inserting their beaks in the bark, and begin to feed on the sap of the tree. White waxy threads soon appear on their backs, and these matting together with the molted skins of the insect added, finally form the scale covering the adult.

The extremely small size of this insect, together with its enormous power of multiplication (a single insect in the spring might easily have over three billion descendants before the winter if no casualties occurred) render it exceedingly difficult to control. Trees are often nearly dead before the presence of this insect is realized, and constant vigilance is necessary to guard against this pest.

If it were possible to reach all the young while they are crawling about or before they produce their covering scales, treatment would be comparatively easy, but as young are constantly appearing from about the middle of June until winter sets in, this is impossible, and materials strong enough to reach and destroy the insects in spite of their protecting scales must be used. The best spray for this purpose is the lime-sulfur wash, applied while no leaves are on, but if for any reason this cannot be used, Scalecide one part, water twelve to fourteen parts, sprayed on during the same time, is a fairly good substitute, if very thoroughly applied. This insect and methods for its control have been very fully considered in Bulletin 116 of this Station.

THE GYPSY MOTH.

(*Porthetria dispar* L.)

The Gypsy Moth is a native of the Old World. It reached Massachusetts about 1868, and has now spread over the entire eastern portion of the state, and is also found in portions of Rhode Island, Connecticut, New Hampshire and Maine. The eggs are deposited in clusters, mixed with hair from the body of the moth, and are laid during the latter part of July, August and early September. They are placed on the trunks, limbs and sometimes even on the leaves of trees and bushes, and also on stones, rubbish or elsewhere on the ground. The clusters are yellowish brown in color because of the hairs present, and may occupy more than a square inch of space.

The eggs hatch in the spring and the tiny caterpillars feed on the leaves of different plants, over four hundred kinds of which are known to serve for this purpose. The feeding is mainly at night, the caterpillars hiding more or less during the day. By the middle or end of June they have become full grown and are two inches or more in length. They now crawl to some partly protected spot, the underside of a limb being a favorite place, and there they change to pupæ, only a few scattered silk threads representing the cocoon. Within the pupa shell the change from the caterpillar to the moth takes place, and when this has been completed the moths appear, most of them being found in July and August.

The male moth is dark brownish gray and mottled; the female is dirty white with irregular dark markings. The female, though provided with wings, is unable to fly.

At any time during the fall and winter months the egg masses may be destroyed by soaking them with creosote oil. A good formula for this purpose is:

Creosote oil,	50%
Carbolic acid,	20%
Spirits turpentine,	20%
Coal tar,	10%

A sufficient amount of this should be applied to each egg mass to insure reaching every egg in it.

The habit the caterpillars have of feeding by night and lying hidden during the day is made use of by putting loose bands of burlap around the trunks of the trees for the caterpillars to hide beneath, these bands being examined every day or two and the caterpillars there being destroyed. Banding in this way should be begun by the first of May. Trees not infested and not touching others can be protected by bands of Tree Tanglefoot around their trunks. Spraying infested trees heavily with arsenate of lead is also a valuable treatment and the clearing out of underbrush is necessary in infested districts. Fuller descriptions and information can be obtained by applying to the Gypsy Moth Commission, 6 Beacon St., Boston, which has excellent illustrated bulletins about this insect for distribution.

THE BROWN-TAIL MOTH.

(*Euproctis chrysorrhœa* L.)

This insect, which is a well-known European pest, was brought to Massachusetts about 1892, and is now found throughout the eastern half of the state, and also in New Hampshire, Maine and the Maritime Provinces, and is likely to be found in northern Rhode Island and northeastern Connecticut, though it has not thus far been reported from there. The adult moths appear early in July and fly for perhaps two weeks. They are pure white except for a golden brown tuft at the end of the body of the female, which has given the insect its name. They spread from an inch to an inch and a half when their wings are extended, and in general much resemble the fall web-worm moth, which, however, has no brown tail.

During July the moths lay their eggs in clusters mixed with the brown hairs from the end of the body. The clusters are usually placed on the underside of leaves and only rarely on the bark, and each includes about three hundred eggs. In August the eggs hatch into tiny caterpillars, which feed on the leaves, keeping together in colonies. They may feed on a large number of kinds of plants, but appear to prefer the pear and other fruit trees, the oak, elm and mountain ash, and when abundant may skeletonize the leaves of an entire tree at this time. In September each colony passes to the tip of some twig and here constructs a tent or nest in which to pass the winter. This tent is of very closely woven silk threads, and is rarely over four or five inches long by two or three inches at its greatest diameter. It may easily be distinguished from the tents of other insects by its toughness and firmness, its small size, by its location at the very tips of the branches, and by the presence within it during the winter of hundreds of caterpillars one-fourth to one-third of an inch in length. After making the tent, the caterpillars may at first leave it on warm days to continue feeding, but they soon retire to it to pass the winter.

In the spring the caterpillars desert their winter quarters and scatter to feed, attacking buds, blossoms and leaves, and becoming full grown by the middle or latter part of June. They then pupate, usually in the hollows formed by drawing the edges of leaves toward each other, though occasionally in other places, and from these pupæ the moths appear early in July.

Though this insect is less universally destructive to vegetation than the Gypsy Moth, the fact that the hairs of the caterpillar, and to some extent of the moths also, are very brittle, and contain a poison irritating to the human skin, makes them serious pests. The most effective methods of control are to cut off and burn the winter tents before the caterpillars scatter in the spring; to spray infested trees with arsenate of lead when the caterpillars begin their work in August (except on trees bearing fruit), and also when the leaves develop in spring; to band uninfested trees not touching those which are infested, with Tree Tanglefoot, though this will not prevent moths from flying to such trees in July and laying their eggs there; and to destroy the moths which have been attracted to lights. Relief from the irritation caused by the poisonous hairs may be obtained by bathing the affected parts with cooling lotions, or by the use of vaseline. For fuller information apply to the Gypsy Moth Commission, 6 Beacon St., Boston.

MAKING AND APPLYING INSECTICIDES

ARSENATE OF LEAD.

Arsenate of soda (50% strength), 4 ounces.
Acetate of lead, 11 ounces.
Water, 100 gallons.

Put the arsenate of soda in two quarts of water in a wooden pail, and the acetate of lead in four quarts of water in another wooden pail. When both are dissolved, mix with the rest of the water. Warm water in the pails will hasten the process. For the elm-leaf beetle use 10 instead of 100 gallons of water. For most shade trees 50 gallons of water is better than 100 gallons.

A number of ready-made arsenates of lead are now on the market, and except when very large amounts are needed it will probably prove cheaper to buy the prepared material than to make it. With this ready-made material, take one pound to fifty gallons of water in general, but five pounds to fifty gallons for the elm-leaf beetle.

KEROSENE EMULSION.

Hard soap, shaved fine, one-half pound.
Soft water, 1 gallon.
Kerosene, 2 gallons.

Dissolve the soap in the water, which should be boiling; remove from the fire and pour it into the kerosene while hot. Churn this with a spray pump until it changes to a creamy, then to a soft butter-like mass. Keep this stock, using one part in nine of water for soft bodied insects such as plant lice, or stronger in certain cases. If the water be hard add borax or soda to soften it before dissolving the soap.

WHALE OIL SOAP.

Potash whale oil soap, 2 pounds.
Hot water, 1 gallon.

For winter use only.

Potash whale oil soap, 1 pound.
Hot water, 6 gallons.

For summer use.

LIME-SULFUR WASH.

Fresh stone lime, 20 to 22 pounds.
Flowers of sulfur or sulfur flour, 18 to 20 pounds.
Water, 45 to 50 gallons.

Slake the lime with some of the water in a large iron kettle, sprinkling in the sulfur gradually. Start a fire under the kettle to continue the heat begun by slaking the lime, and boil until the mixture becomes dark orange in color, adding water until 35 or 40 gallons are in the kettle. Boiling should probably take 40 minutes to an hour. Stir frequently. A successfully prepared lot should have little sediment at the bottom when the boiling is finished. Strain through a fine meshed strainer into the spray pump, adding the rest of the water, and spray while warm. It is generally better to use only the freshly prepared wash, though good results have sometimes been obtained with it when it has stood over night. It should not be applied to trees after the leaves have opened.